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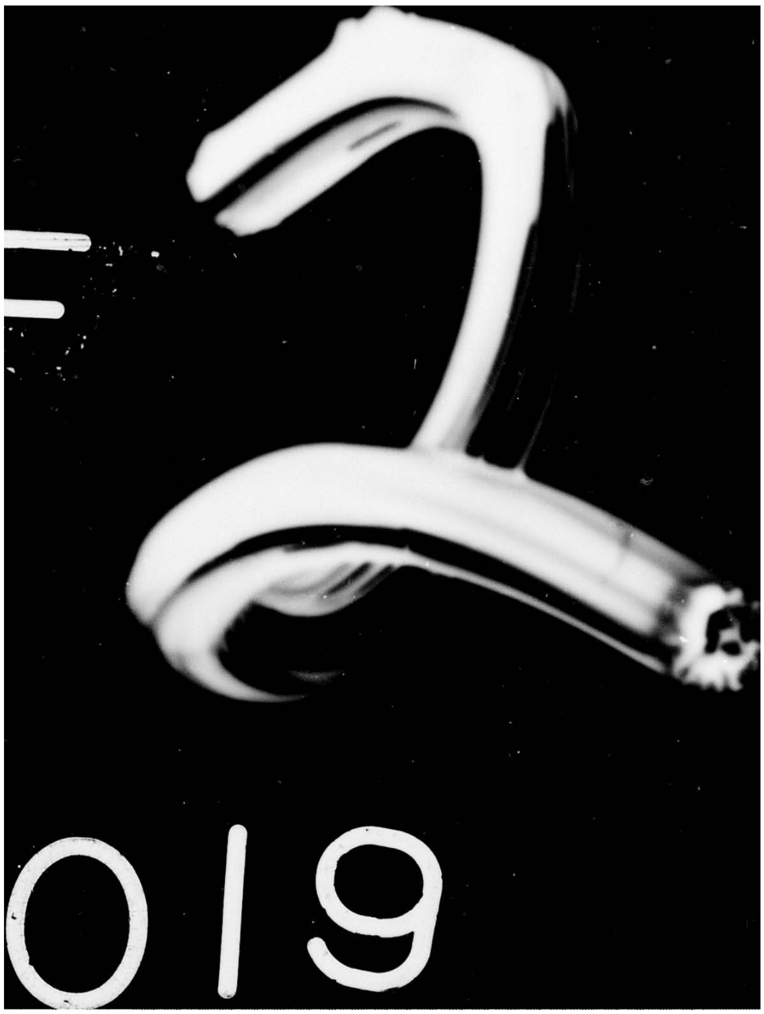
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This report describes how to use the MIDTRAN computer code for calculation of atmospheric transmission and radiation in the 2 - 5 μm spectral region. The code contains the flexibility of the LOWTRAN code and the high resolution technology of the HITRAN compilation of spectral lines to yield a flexible code with a spectral resolution of approximately 0.1/cm$^{\cancel{-1}}$. The code can be used for a variety of paths (horizontal, vertical, slant, etc.) and for the six different model atmospheres (as contained in LOWTRAN). The spectral absorption coefficients which are calculated

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Abstract (Continued)

from the HITRAN data tape are stored in a tape library. This tape library is used by MIDTRAN to calculate the spectral absorption coefficients. For radiation calculations, the user has the option of including a background blackbody source of arbitrary temperature.

18. (Continued)

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Defense Advanced Research Projects Agency or the U.S. Government.

TABLE OF CONTENTS

Table of Contents (Continued)

1. INTRODUCTION

MIDTRAN is a computer code which calculates transmittance and radiation for paths through the earth's atmosphere in the 2 - 5 μm spectral region. The code is based on a marriage of the AFGL codes LOWTRAN3[1] and HITRAN.[2] The overall structure and formats of LOWTRAN3 have been retained for the input parameters, path geometry and continuum transmittance components. The HITRAN data tape is used to precalculate the spectral absorption properties of atmospheric molecules, which are stored on tape and then used as input data by MIDTRAN. The use of these data stored on external library tapes allows MIDTRAN to perform calculations for multilayered atmospheres at reasonable speeds and with a spectral resolution of 0.05 cm^{-1} or better. Because of the library tape's present structure, MIDTRAN is best suited for paths which fall below 15 km altitude at some point. The code is written in FORTRAN and is compatible with CDC and IBM formats. For radiation calculations, the user has the option of specifying a background blackbody source of arbitrary temperature and emissivity and then calculating the radiation as seen through an atmosphere. In following the LOWTRAN3 structure, the user has the choice of six model atmospheres or radiosonde data and of different atmospheric paths, horizontal, vertical, or downward. Thus, MIDTRAN has flexibility for those systems studies which require atmospheric transmittance at lower altitudes while maintaining good spectral resolution.

Section 2 gives a description of the MIDTRAN software and describes the MIDTRAN library tapes. Instructions for using MIDTRAN are in Section 3 and

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[1] J. Selby and R. McClatchy, "Atmospheric Transmittance From 0.35 to 28.5 μm; Computer Code LOWTRAN3," Report No. AFCRL-TR-75-0255, AFGL/OPI, Hanscom AFB, Mass., May 1975.

[2] R. McClatchy, et al., "AFCRL Atmospheric Absorption Line Parameters Compilation," AFCRL-TR-73-0096, AFGL/OPI, Hansom AFB, Mass., January 1973.

comparisons to transmittance data are in Section 4. The appendices contain listings of MIDTRAN, a sample run, a list of variables, a MIDTRAN flowchart, and a listing of MRDAT, the program which generates the library tapes.

The support furnished by the Naval Weapons Center and the Air Force Avionics Laboratory via the Air Force Geophysics Laboratories is greatfully acknowledged. The contract monitors are Mr. S. Ted Smith (NWC), Dr. R. Sanderson (AFAL), and Mr. B. Sandford (AFGL). Previous support of the Defense Advanced Research Projects Agency for the development of a preliminary version (MRDA) of MIDTRAN for use on an HP-2100 minicomputer[(3)] is acknowledged. The present code supersedes the earlier MRDA code.

The MIDTRAN code can be directly used on either a CDC6600 computer or a minicomputer with virtual memory capability. Execution times on a CDC6600 for both transmittance and radiation is approximately 1.8 sec/wavenumber for a path transversing 11 model atmosphere layers and in steps of 0.01 cm^{-1} (100 calculations/wavenumber). Calculational times on the PRIME 400 minicomputer are about 4 times slower. Total times for a calculation depend on the machine's tape read speed; considerable time can be spent by the PRIME in skipping over files to get to a spectral region near the end of a library tape. The code is still in the developmental stage. Qualified requestors may obtain copies of the code and library tapes from Aerodyne Research, Inc.; a charge will be made for tape duplication.

[3] D. Kryger and D. Robertson, "MRDA - A Medium Resolution Data Analysis Code for the HP2100 Minicomputer," AFGL-TR-77-0044, AFGL/OPR Hanscom AFB, Massachusetts 01731.

2. DESCRIPTION OF MIDTRAN SOFTWARE

2.1 The MIDTRAN Code

MIDTRAN is designed to make medium resolution atmospheric transmission and radiation calculations in the range of 1800 to 6000 cm^{-1} over a wide variety of geometrical paths. The first part of the calculation consists of predicting the continuum transmissions (H_2O, N_2, molecular scattering) along with aerosol absorption for the chosen path and wavenumber interval. These calculations are carried out by what is essentially LOWTRAN3[1] with all the spectral calculations removed. In the second part of MIDTRAN, the medium resolution spectral calculations are performed. Magnetic tapes which contain a complete library of extinction coefficients are used to provide the data for computing the spectral contributions. After having calculated the total transmission due to the spectral structure, the program then combines the continuum and medium resolution results; if desired, the radiation is also calculated at each frequency. The frequencies, radiances, and transmittances are then written to a disk file, associated with FORTRAN logic unit 9. In the third part of MIDTRAN, this disk file is rewound, and the transmittances and radiances are then degraded to the desired spectral resolution using the available slit function before being printed out and/or plotted.

In the process of computing the continuum results, intermediate values are saved for later use in the spectral calculations. For example, the pressure, temperature, and altitude of each layer traversed by the geometric path are stored. In addition, the transmission through each layer is also stored in an array TRAN1 for use in calculating the radiation. Finally, the atmospheric concentration of H_2O and O_3 in each layer along with the molecular density (of all gases) for the particular path through each layer is saved. Using this information from the continuum part of the calculation and data from the library tape, MIDTRAN calculates the spectral transmission and radiation over the geometric path at frequencies defined by the

input. The spectral absorption coefficients are read from the library tape. They are tabulated for the six important infrared atmospheric molecules:

H_2O, CO_2, O_3, N_2O, CO, and CH_4.

The tapes are organized in 2 cm^{-1} blocks over the 1800 to 6000 cm^{-1} range that MIDTRAN operates. In each wavenumber block, the extinction coefficients for the six molecular species are tabulated at 9 pressure-temperature points, the wavenumbers being chosen to represent the structure of the absorption spectra for the particular species in that wavenumber block. For each species, the wavenumbers were selected so as to define the spectra by identifying the most important lines in the region. In combining the separate contributions from far and near spectral lines, the extinction coefficients were calculated near the line center at 10 points, spaced 0.01 cm^{-1} apart, and at 0.1 cm^{-1} intervals between adjacent strong lines. In order to obtain the extinction coefficient at a particular pressure, temperature and frequency, the program performs linear interpolations over the pressure/temperature matrix and then over frequency.

Presently, the slit function library in MIDTRAN contains the option for no slit function at all and for a generalized slit function which requires the user to input two arrays for its definition, the slit width and the shift. The plotting option requires that the user input certain titles, initial axis values, and scaling parameters for use by the plotting software. The plotting software now in the program is designed for a PRIME 400 system with a Versatec printer/plotter. The user must examine this part of the code to determine its compatability with his system. Printed output is columnar and is blocked in sections which contain a maximum of 240 pairs of output data.

2.2 The MIDTRAN Library Tapes

The MIDTRAN Library tapes contain the spectral absorption coefficients for the six atmospheric species which have significant absorption in the 1800 - 6000 cm^{-1} region. The species are: H_2O, CO_2, O_3, N_2O, CO, and CH_4. The absorption

coefficients are calculated at selected (P, T, ν) points and then written onto a tape that is accessed by MIDTRAN. The CDC6600 computer at AFGL was used to generate these tapes.

2.2.1 Choice of Spectral Absorption Coefficients

The data in the MRDA library tape are organized so as to define the absorption spectra for the species in as compact a form as possible. Thus, nine pressure-temperature (P, T) points are used to describe the atmosphere, and the total number of wavenumber points within each block is limited to 250.

The choice of the (P, T) points is based on the expected range of atmospheric pressures and temperatures. Figure 1 shows the (P, T) variability, along with illustrative radiosonde data, taken from several AFGL Mission.[(4)] The heavy dots within the circles show the nine (P, T) points at which the spectral absorption coefficients are calculated. Pressure/temperature points for pressures below 100 mb are not included in the tape at this time, since the dominant part of the atmosphere is at lower altitudes. The tape program contains Doppler line-shapes, so the user can generate his own high altitude tape to use with MIDTRAN.

A considerable savings in the total number of wavenumber points at which the spectral absorption coefficients must be stored is obtained by identifying the stronger spectral lines within each wavenumber block. When one or more of the species have strong lines within a block, the absorption coefficients are calculated at the peak, at 10 points about line center 0.01 cm^{-1} apart, and at intervals of 0.1 cm^{-1} between adjacent peaks. Spectral absorption coefficients for intermediate values are obtained by linear interpolation.

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[4] B. Sandford, et al., "Aircraft Signatures in the Infrared 1.2 to 5.5 Micron Region," AFGL-TR-76-0133, Air Force Geophysics Laboratory (OPR), Hanscom AFB, Mass., 01731, (June 1976).

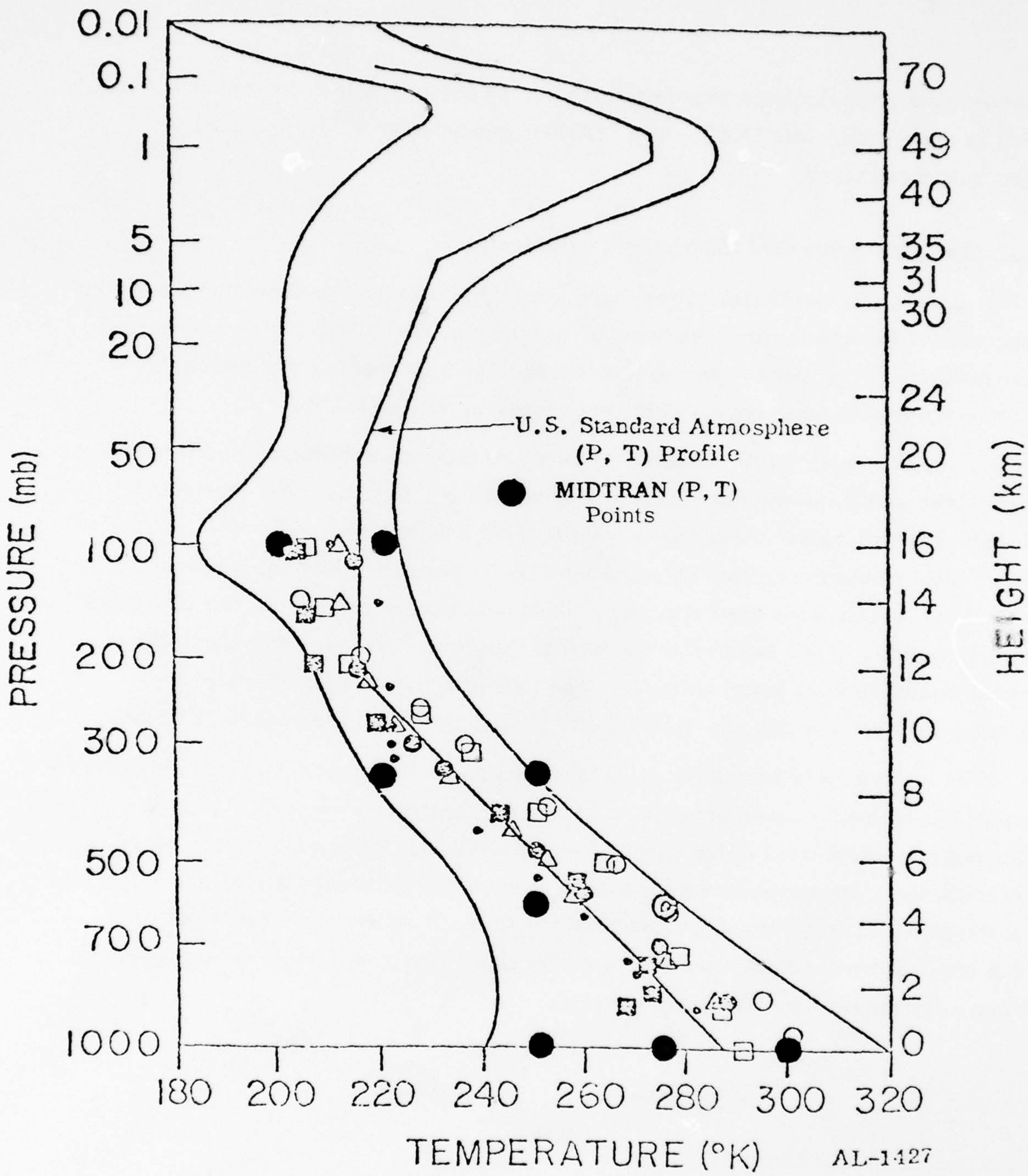

Figure 1 - Temperature and Pressure Variations of the Atmosphere. Radiosonde Data from Several AFGL Measurements are Indicated. The Outer Lines Indicate the Approximate Range of Atmospheric Temperature Fluctuations. The Center Line is the U.S. Standard Atmosphere.

2.2.2 The MRDAT Code

The MRDAT code is operational on the AFGL CDC6600 computer. It calculates the spectral absorption coefficients from line parameters contained on the HITRAN data tape[(2)] and writes them to an external tape. These tapes comprise the MIDTRAN tape library. The Lorentz lineshape function is used to describe the contribution of overlapping line tails. In the 2360 - 2500 cm^{-1} spectral region, the CO_2 lineshape includes the Burch form factor[(5)] as modeled by Kaplan, et al.[(6)] A Voigt lineshape is included in the program; internal logic selects this lineshape when the Doppler width becomes comparable to the Lorentz width.

The absorption coefficients are calculated in two steps. The contribution of lines external to each wavenumber block are calculated at two points (the edges of the block); linear interpolation is used to determine their contribution at intermediate frequencies. The contribution of the nearby lines is calculated at each wavenumber point within the block. The two results are combined and then written onto the library tape.

The spectral absorption coefficients for each molecule are calculated for 1 cc of pure gas at STP (i.e., 2.69×10^{19} molecules). MIDTRAN includes the concentration when calculating the transmittance. The codes are written for 9 (P, T) points and 6 atmospheric molecules. They are specified in the MRDAT input cards. So long as these parameters maintain the structure shown in Fig. 1, new tapes which are tailored to specific problems (like high altitude) are easily generated.

2.2.3 MRDAT Input Parameters

The spectral absorption coefficients are calculated from the molecular line parameters on the AFGL HITRAN data tape. A listing of the program (MRDAT) is

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[5] D.E. Burch, D.A. Gryvnak, R.R. Patty, and C.E. Bartky, Journal, Optical Society of America, 59, 267, 1969.

[6] L.D. Kaplan, M.T. Chahine, J. Susskind, J.E. Searl, Applied Optics, 16, 322, 1977.

given in Appendix B. The data for the input parameters are given by the following sequence of read input lists:

1.	NPTPTS, MSPEC	Format (8I2)
2.	P (I), I = 1, NPTPTS	Format (8E10.0)
3.	T (I), I = 1, NPTPTS	Format (8E10.0)
4.	W (M), M = 1, 7	Format (7E10.3)
5.	V1, V2, DV, VLWST, VHGHST, DELTV, BOUND	Format (7E10.3)
6.	SSTR, VBLOCK, DV2	Format (3E10.3)

The input quantities are:

NPTPTS	=	number of (P, T) points
P	=	pressure values
T	=	temperature values
W	=	species column density = 0.269E20 molecules/cm^2 for (H_2O, CO_2, O_3, N_2O, CO, CH_4, O_2)*
V1	=	lower frequency limit (cm^{-1}) of the library tape
V2	=	upper frequency limit (cm^{-1}) of the library tape
DV	=	frequency increment for calculating between strong lines
VLWST	=	lower frequency bound, cm^{-1}, for consideration of distant lines. (presently, overidden internally)
VHGHST	=	upper frequency bound, cm^{-1}, for consideration of distant lines. (presently, overidden internally)
DELTV	=	frequency increment for distinguishing between near and far lines.
BOUND	=	distance (cm^{-1}) from line center beyond which a line is not included, presently fixed at 20.0 cm^{-1}.
SSTR	=	lower line intensity limit used for accepting lines.
MSPEC	=	identification of the six molecules (Set = 123456).[2]

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*Since oxygen does not have any important absorption bands below 6000 cm^{-1}, it is not included as one of the six species in MIDTRAN, but could be used in place of a molecule on a new tape library.

VBLOCK = frequency interval length (cm^{-1}) into which the range [V1, V2] is divided for blocking.

DV2 = frequency increment (usually 0.1 cm^{-1}) for calculations between strong lines.

Figure 2 is a schematic which illustrates the choice of these wavenumber parameters.

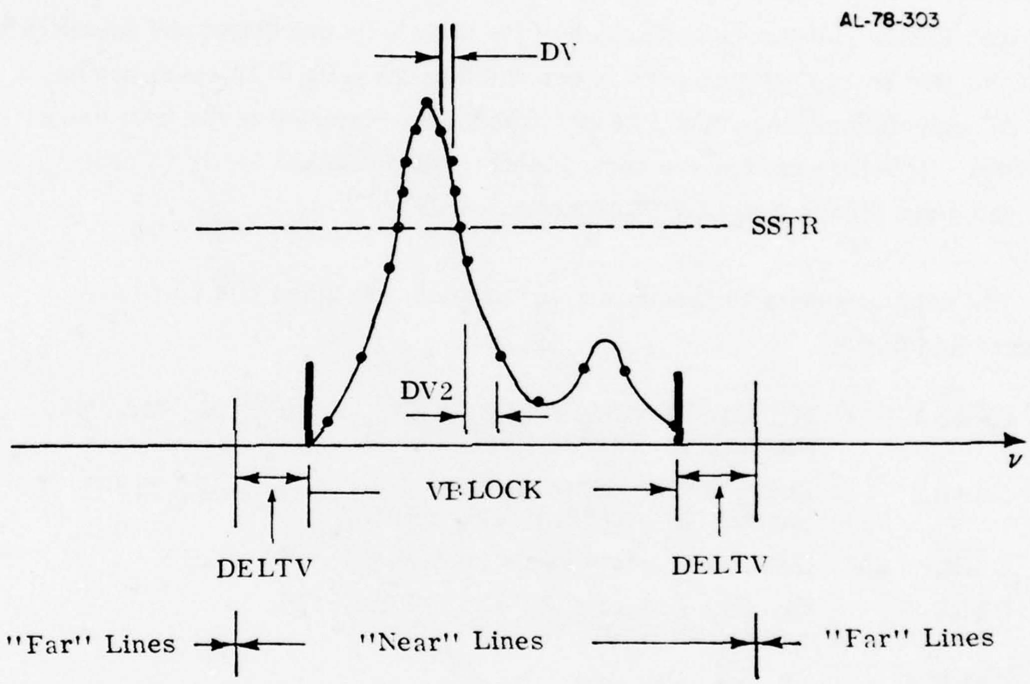

Figure 2. Schematic Showing the Definition of Wavenumber Parameters for MRDAT. Note that the Second Line is Weaker Than SSTR

3. OPERATING INSTRUCTIONS

3.1 Input Data and Formats

Many of the input cards and operations are very similar to those of LOWTRAN. In particular, the card input sequence is nearly identical. The input cards can be divided into two blocks, specification of the case to be calculated and specification of slit function and/or plotting parameters and formats. Up to 10 cases can be run. All calculations (including multiple cases) are completed in the first block (CARDS 1 - 4) before reading the second block of data (CARDS 5 - 7). Cards 1, 3, and 4 are identical to LOWTRAN3 input cards.[1]

The data necessary to specify a given problem are given in a four card sequence as follows:

CARD 1	MODEL, IHAZE, ITYPE, LEN, JP, IM, M1, M2, M3, NLDAT, R Format (10I3, F10.3)
CARD 2	IRAD, EMIS, TBACK, NTS, NTP, NRS, NRP, XORG, YORG Format (I10, 2F10.3, 4I5, 2F10.3)
CARD(s) 2A	(Atmosphere data cards when M = 0 or M = 7)
CARD 3	H1, H2, ANGLE, RANGE, BETA, VIS Format (6F10.3)
CARD 4	V1, V2, DV Format (3F10.3)
CARD 1	(Model = -1 to indicate last calculation)
CARD 5	TITLE Format (20A4)

(Slit Function Parameters)

CARD 6A	WIDTH, SHIFT, NS Format (2F10.5, I10)
CARD 6B	XSS (I), I = 1, NS Format (8F10.5)
CARD 6C	SS (I) I = 1, NS Format (8F10.5)

(Plotting Parameters)

CARD 7A	XTITLE Format (20A4)
CARD 7B	YTITLE Format (20A4)
CARD 7C	XAXIS, XINIT, XSCALE, DXT, NMINX Format (4E10.4, I10)
CARD 7D	YAXIS, YINIT, YSCALE, DYT, NMINY Format (4E10.4, I10)

If MODEL = 0 or 7, meteorological data used to describe the atmosphere are inputted on CARD(s) 2A. Transmittance and radiation calculations for all the various cases are completed with results written to an external file, before either the slit function is used or the plotting routine is employed. The external file is associated with FORTRAN logical unit 9. CARDS 1 - 4 can be repeated to perform up to ten calculations, ending with a MODEL = -1 on CARD 1. Another cyclical sequence of input data follows this card to specify the title, slit function parameters, and plotting parameters for each of the cases. Up to two plots (radiation and transmittance) can be made for each case and card set. The first block (CARDS 1 - 4) is described in Subsection 3.2 and the second block in Subsection 3.3.

3.2 Input Parameters

3.2.1 CARD1: MODEL, IHAZE, ITYPE, LEN, JP, IM, M1, M2, M3, NLDAT, R

The parameter, MODEL, selects one of the six geographical model atmospheres,[1] specifies that meteorological data are to be used in place of the standard models, or indicates the end of the first blocks of data (the second block being the output parameters).

IHAZE specifies whether aerosol attenuation is to be included in the calculation or not. For any problem, the atmospheric path must be specified as one of three types according to ITYPE and LEN. The rest of the quantities given on CARD 1 (which can be left blank if not required) provide the user with options to suppress printing (JP), to intermix the six standard model atmospheres (M1, M2, M3), to input a new model atmosphere (IM, NLDAT), and to specify the earth radius (R). The options for the above parameters and their use are described below:

MODEL	=	-1	indicates end of first data blocks
	=	0	indicates meteorological data are specified for a horizontal (constant pressure) path.
	=	1	selects TROPICAL MODEL ATMOSPHERE
	=	2	selects MIDLATITUDE SUMMER
	=	3	selects MIDLATITUDE WINTER
	=	4	selects SUBARCTIC SUMMER
	=	5	selects SUBARCTIC WINTER
	=	6	selects 1962 US STANDARD
	=	7	indicates a new model atmosphere (or radiosonde data) is to be inserted
IHAZE	=	0	means no aerosol attenuation included in the calculations.
	=	1	or 2 if aerosol attenuation is required (see also, CARD 2).

If IHAZE is set equal to 1 or 2 and visual range (VIS) is not specified on CARD 2, the program will then automatically select visual ranges of 23 or 5 km, respectively.

ITYPE	=	1	for a horizontal (constant pressure) path.
	=	2	for a vertical or slant path between two altitudes.
	=	3	for a vertical or slant path to space.

The TYPE 1 path should not be confused with a 90^{o} path where the local height at the end of the trajectory is significantly different from that at the beginning. In such a case, specify the path according to ITYPE = 2.

LEN	=	0	for normal operation of program.
	=	1	selects the downward TYPE 2 path shown in Figure 3(e).

The parameter LEN, can be ignored (that is, left blank) for the majority of cases. It need only be used for a downward looking path (H2 < H1) when two paths are possible for the same input parameters. In such a case, a computer printout

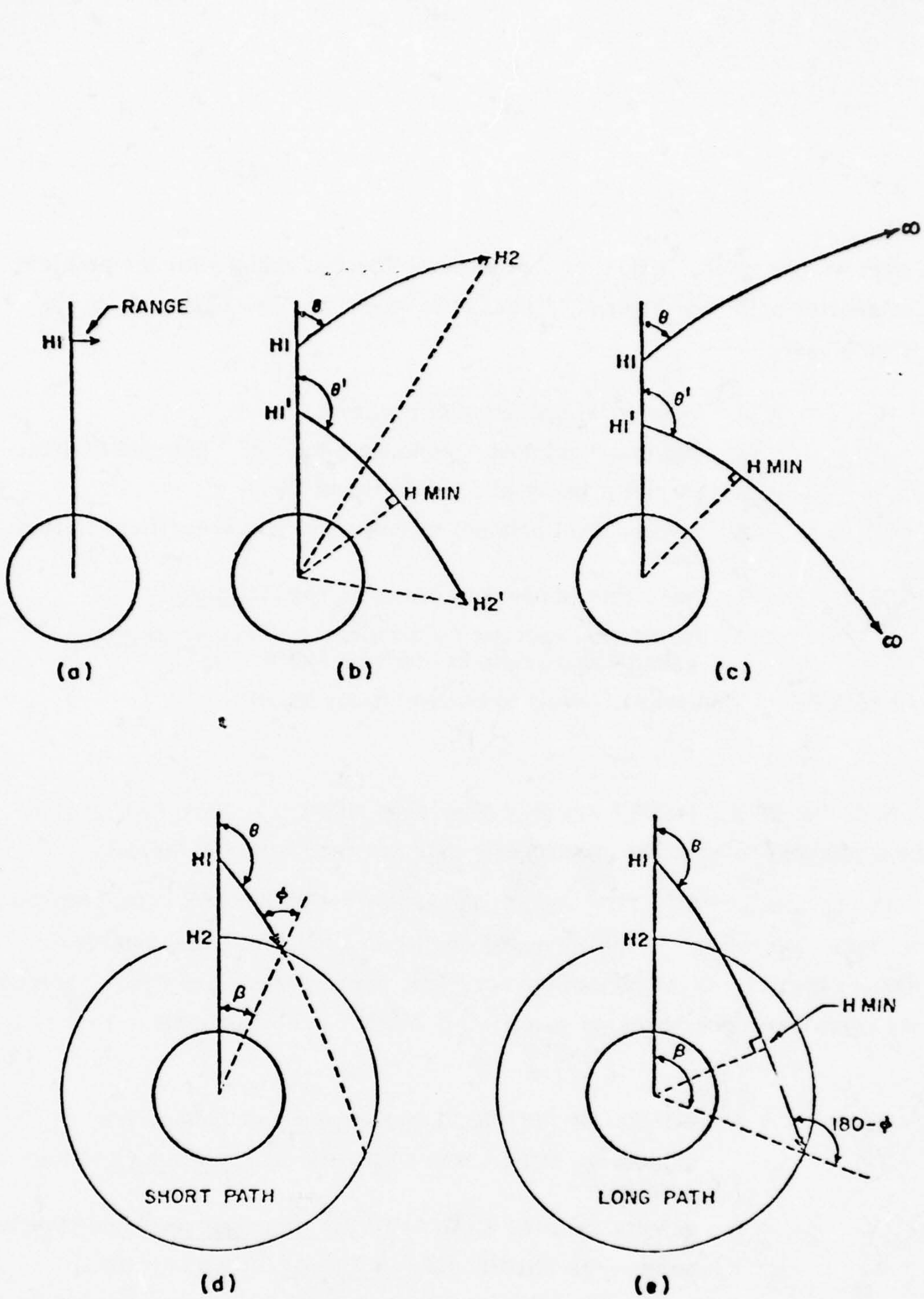

Figure 3. Geometrical Path Configuration for: (a) Horizontal Paths (Type 1), (b) Slant Paths Between Two Altitudes H1 and H2 (Type 2), and (c) Slant Paths to Space (Type 3). For Downward Looking Paths Where HMIN < H2 < H1, Two Trajectors Are Possible As Indicated in (d) and (e). The Angle θ Corresponds to ANGLE on CARD 3. From Ref. (1).

statement will be given, indicating that the user has two choices for the problem and the shorter path (see Figure 3(d)) has been executed. Set LEN = 1 for the longer path case.

JP	= 0	for normal operation of program.
	= 1	additional printout, including a 0.1 cm^{-1} printout of data.
	= 2	partial printout at a resolution of DV.
	= 3	highest level printout includes absorption coefficients from tape.
IM	= 1	when radiosonde data are to be read in <u>initially</u>.
	= 0	for normal operation of program or when <u>subsequent</u> calculations are to be run with MODEL = 7.
NLDAT	=	number of levels to be read in for MODEL = 7.

Note that IM and NLDAT are only used when MODEL = 7 and then only on the first calculation when the atmospheric data are read from Card(s) 2A.

The parameters M1, M2, and M3 can each take any integral value between 0 and 6. Set M1 = M2 = M3 = 0 for normal operation of program. They modify or supplement the altitude profiles of temperature, water vapor, and ozone, respectively, for any given atmospheric model specified by MODEL. For example:

M1	= 1	selects the TROPICAL <u>temperature</u> altitude profile
	= 2	selects the MIDLATITUDE SUMMER <u>temperature</u> altitude profile
	= 6	selects the 1962 US STANDARD <u>temperature</u> altitude profile
M2	= 1	selects the TROPICAL <u>water vapor</u> altitude profile
	= 2	selects the MIDLATITUDE SUMMER <u>water vapor</u> altitude profile
	= 6	selects the 1962 US STANDARD <u>water vapor</u> altitude profile
M3	= 1	selects the TROPICAL <u>ozone</u> altitude profile
	= 2	selects the MIDLATITUDE SUMMER <u>ozone</u> altitude profile

R	=	radius of the earch (km) at the particular geographical location at which the calculation is to be performed.

If R is left blank, the program will use the midlatitude value of 6371.23 km when MODEL is set equal to 0 to 7. Otherwise, the earth radius for the appropriate standard model atmosphere (specified by MODEL) will be used.

When MODEL = 0 or 7, the new atmosphere (model or radiosonde data) is inserted between CARDS 2 and 3.

3.2.2 CARD 2: IRAD, EMIS, TBACK, NTS, NTP, NRS, NRP, XOR, YOR

This card is in addition to the LOWTRAN input cards. It determines whether atmospheric radiation is calculated and specifies the slit function and plot parameters.

IRAD	=	1/0	if radiation calculations are/are not to be made.
EMIS	=		emissivity of a background radiation source located at the beginning of the path. (Include, if IRAD = 1.)
TBACK	=		temperature (in degrees Kelvin) of the background radiation source. (Include, if IRAD = 1.)
NTS	=	0	when using a previously specified value.
	=	+/-1	use variable slit function on transmittance and plot/don't plot.
	=	+/-3	don't use any slit function (leave points as they are) for transmittance and plot/don't plot.
NTP	=	+1	plot transmittance vs cm^{-1}.
	=	-1	plot transmittance vs microns.
NRS	=	0	±1, ±3 (same as NTS, for radiation).
NRP	=	±1	(same as NTP, for radiation).
XOR YOR	=		coordinates (in inches) for the lower left corner of the plot.

The background radiation source is calculated using the temperature dependence of the blackbody function and a surface emissivity given by EMIS. Radiation from this gray body source is then propagated through the atmosphere from H1 to H2.

It should be noted that all transmittance and radiation calculations for all of the various cases are made and written to an output file, before any slit functions are used or plotting software is employed. The external file is associated with FORTRAN logical unit 9. After the transmittance and radiation calculations for all of the cases have been written to unit 9, it is rewound and used as input for the slit function and plotting subroutines. For degrading and plotting, the order of processing then proceeds as follows: CASE 1 transmittance, CASE 2 transmittance, ..., CASE N transmittance, CASE 1 radiation, CASE 2 radiation, ..., Case N radiation. This is illustrated in the following matrix:

NTS (CASE 1),	NTP (CASE 1)
NTS (CASE 2),	NTP (CASE 2)
.	.
.	.
.	.
.	.
NTS (CASE N),	NTP (CASE N)
NRS (CASE 1),	NRP (CASE 1)
NRS (CASE 2),	NRP (CASE 2)
.	.
.	.
.	.
.	.
NRS (CASE N),	NRP (CASE N)

Briefly, Column 1 monitors the present slit function being used and whether or not to plot. Column 2 determines the units if the user has chosen to plot.

Once a particular slit function has been specified in Column 1; under the NTS or NRS parameter, the NTS/NRS column can be left blank until a new slit function is to be used (with the exception that in going from plotting to no-plotting or vice versa the NTS/NRS parameter has be to explicitly entered).

Likewise, the NTP/NRP parameter can be left blank after being specified, until a new set of plotting units is desired. However, the NTP/NRP parameter need not be respecified following a series of no-plot options under the NTS/NRS parameter.

3.2.3 CARD 2A: (For MODEL = 0 or 7)

If MODEL = 0 and ITYPE = 1, then meteorological data for a horizontal (constant pressure) path are to be inserted between CARD 2 and CARD 3 as follows:[1]

H1, P, T, DP, RH, WH, WO, VIS, RANGE
Format (3F10.3, 2F5.1, 2E10.3, 2F10.3),

where the above parameters refer to altitude (km), pressure (mb), ambient temperature (^{o}C), dew point temperature (^{o}C), relative humidity (%), water vapor density (gm m^{-3}), ozone density (gm m^{-3}), visual range (km), and path length (km), respectively. It is only necessary to specify the quantities underlined with the solid line and one of the quantities underlined with the dashed line. The ozone density WO can be specified using the parameter M3 on CARD 1, if data are not available. In the latter case, a value will be calculated at altitude H1, based on the appropriate model atmosphere selected by M3.

If MODEL = 7 and IM = 1, then a new model atmosphere must be inserted at this point, between CARD 2 and CARD 3.[1] The number of atmospheric levels to be inserted is given by NLDAT on CARD 1. The format for atmospheric data at each of the levels is:

Z, P, T, DP, RH, WH, WO, AHAZE
Format (3F10.3, 2F5.1, 2E10.3, F10.3)

The first level should be at Z = 0.0. These parameters are the same as defined above in this subsection, excepting AHAZE, the aerosol number density (cm^{-1}). It is only necessary to specify those quantities underlined with a full line and one of the quantities underlined with the dashed line. If the aerosol number density was not measured as a function of altitude and the user wishes to include aerosol

attenuation in the calculation, set IHAZE = 1 on CARD 1. In this case, MIDTRAN will use the aerosol models already contained in the program and interpolate to give aerosol number density values at the same altitudes as the radiosonde (or new model atmosphere) data. The program will then look for a sea level visual range (VIS) to be specified on CARD 3. If VIS is not specified, a 23 km sea level visual range will be assumed. If aerosol attenuation is not required, set IHAZE = 0 on Card 1 as before.

3.2.4 CARD 3: H1, H2, ANGLE, RANGE, BETA, VIS

CARD 3 is used to define the geometrical path parameters for a given problem.

H1	=	initial altitude (km)
H2	=	final altitude (km)
ANGLE	=	initial zenith angle (degrees) as measured from H1
RANGE	=	path length (km)
BETA	=	earth center angle subtended by H1 and H2 (degrees)
VIS	=	sea level visual range (km)

It is <u>not</u> necessary to specify every quantity given above, only those that adequately describe the problem according to the parameter ITYPE (as described below).

(1) Horizontal Paths (ITYPE = 1)

- (a) specify H1, RANGE, and VIS only
- (b) if nonstandard meteorological data are to be used (that is, is MODEL = 0 on CARD 1), then the radiosonde data must be specified on CARD 2A and CARD 3 is omitted.

(2) Slant Paths to Space (ITYPE = 3)

- (a) specify H1, ANGLE, and VIS
- (b) specify H1, HMIN, and VIS (for limb viewing problem where HMIN is the tangent height or minimum altitude of the path.)

(3) Slant Paths Between Two Altitudes (ITYPE = 2)

(a) specify H1, H2, ANGLE, and VIS

(b) specify H1, ANGLE, RANGE, and VIS

(c) specify H1, H2, RANGE, and VIS

(d) specify H1, H2, BETA, and VIS

For cases (b) and (c), the program will calculate H2 and ANGLE assuming no refraction and then proceed as for case (a). This method of defining the problem should be used when refraction effects are not important; for example, consider ranges of a few tens of km at zenith angles less than 80°. It can also be used for larger angles (including 90°) provided that the path lies within one atmospheric layer.

Leave ANGLE and RANGE blank in case 3(d). This method can be used when the geometrical configuration of the source and receiver is known accurately, but the initial zenith angle is not known precisely due to atmospheric refraction effects. BETA is most frequently determined by the user from ground range information.

In the cases of 2(b) and 3(d) above, the subroutine, ANGLE, is called in the program to determine the appropriate input zenith angle by the LOWTRAN3 iterative technique(1) that takes atmospheric refraction into account.

3.2.5 CARD4: V1, V2, DV Format (3F10.3)

The spectral range over which transmittance data are required and the spectral increments at which the results are calculated is determined by this card.

V1 = initial frequency in wavenumbers (cm^{-1})

V2 = final frequency in wavenumbers (cm^{-1}) where V2 > V1

DV = frequency increment (or step size) (cm^{-1})

Note that $\nu = 10^4/\lambda$ where ν is the frequency in cm^{-1} and λ is the wavelength in microns.

For lower altitude paths, values of DV around 0.05 cm^{-1} give sufficient accuracy; for high altitudes, 0.02 or even 0.01 cm^{-1} is necessary.

This completes the set of cards necessary to specify one transmittance/ radiation calculation. If more cases are desired, repeat the sequence. If no more cases are desired, CARD 1 with MODEL = -1 is inserted after CARD 4 and before the slit function/plot cards that are described in the next section.

3.3 Output Parameters

In the same way that the input data blocks are given in sequence, another sequence of data specifying the output format and parameters must be given. The MODEL = -1 card separates the two groups of cards. In the second sequence, the title, slit function, and plotting cards for each transmission or radiation calculation must be specified. Generally, one complete cycle in the sequence from this second section of input data is structured as follows:

CARD 5	TITLE
CARDS 6A - 6C	SLIT FUNCTION PARAMETERS
CARDS 7A - 7D	PLOTTING PARAMETERS

All of these calculations are executed in one call to subroutine LIB, which is made just prior to stopping above statement #27.

3.3.1 CARD 5: TITLE (20A4)

The title is used on the plot and is printed with no change.

3.3.2 CARDS 6:

WIDTH, SHIFT, NS	Format (2F10.5, I10)
XSS(I), I = 1, NS	Format (8F10.5)
SS(I), I = 1, NS	Format (8F10.5)

WIDTH	=	width of slit function in cm^{-1}
SHIFT	=	distance (cm^{-1}) between points at which the slit function is calculated
NS	=	number of (XSS, SS) points to define the slit function (max. 8)
XSS	=	wavenumber coordinate of slit function points
SS	=	weighting function values for slit function

When no slit function is desired (i.e., print the results directly), Cards 6 are omitted. This is determined by setting NTS or NRS equal to ± 3 in Card 2. An illustrative example for the generalized slit function is given in Figure 4. The results are degraded to the desired resolution by integrating over the slit function. If the same slit function is used for subsequent calculations, Cards 6 are omitted. This omission must be reflected by zeros for the NTS and NRS parameters in Card 2. Arbitrary values of SS and XSS can be used, because the slit function is normalized.

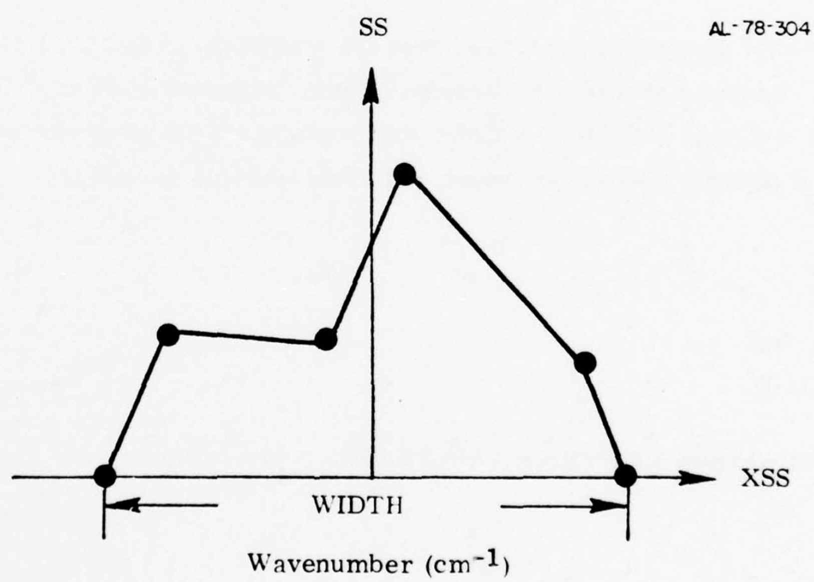

Figure 4. Example of a Generalized Slit Function Specified By Six Values of XSS and SS

3.3.3 CARDS 7:

XTITLE	Format (20A4)
YTITLE	Format (20A4)
XAXIS, XINIT, XSCALE, DXT, NMINX	Format (4E10.4, I10)
YAXIS, YINIT, YSCALE, DYT, NMINY	Format (4E10.4, I10)

XTITLE	=	Title for abscissa units
YTITLE	=	Title for ordinate units
XAXIS	=	Length of x-axis in inches
XINIT	=	Value of x at the origin
SCALE	=	Change in value of x per inch of plot
DXT	=	x-units between major tic marks
NMINX	=	Number of minor tic marks between the major ones.

(Same definitions for y-axis.)

These plot parameters are those that are necessary to specify a plot on the PRIME 400 computer at Aerodyne Research, Inc. The user must modify these parameters and their definition in order to be compatible with his plotting software. The external plotting subroutines which MIDTRAN expects to find are:

AXIS,
PLOT,
INIT, and
ENDPLT.

They are called from subroutines LIB, FRAME, and PROUT.

4. COMPARISON TO DATA

Comparison of atmospheric transmittance calculated using MIDTRAN is made to data taken by NRL.[7] The comparisons show that the code is able to calculate the data's spectral structure. Figure 5 shows NRL data taken for a 5.12 km sea level horizontal path at a spectral resolution of 0.08 cm^{-1} and a MIDTRAN calculation performed at a resolution of 0.01 cm^{-1} and degraded to 0.08 cm^{-1} using a triangular slit function. The calculations combine the molecular spectral structure of a HITRAN calculation and the H_2O and N_2 continuum components from LOWTRAN. This yields a calculated spectra that compares favorably with the data.

Figure 6 shows a comparison to the same data but on an expanded scale in the 2385 - 2450 cm^{-1} spectral region. This illustrates the fall-off in the transmittance as one moves in towards the 4.3 μm CO_2 band. The CO_2 spectral absorption coefficients in this region include the tail contribution from all lines in the CO_2 band. The form factor of Kaplan, et al.[6] was used to modify the Lorentz lineshape. The calculations have the correct roll-off as exhibited by the data but underestimate the strength of this effect. Since the difference between the calculated and measured spectra decreases as one moves away from the CO_2 band, the difference is most likely due to the modeling of the CO_2 form factor. The parameterization used by Kaplan, et al. is already larger than the form factor calculated by Burch, et al.[5] from their data, so no further changes were made to fit these data. Further theoretical studies and measurements at different atmospheric temperatures are required to better parameterize the lineshape in this region (and to verify that the strength is really due to CO_2 and not to unexpected spectral structure in the N_2 and/or H_2O continuum components).

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[7] K. Haught and J. Dowling, "Long Path High Resolution Field Measurements of Absolute Transmission in the 3.5 to 4.0 μm Atmospheric Window," Optics Letters, 1, 121 (1977).

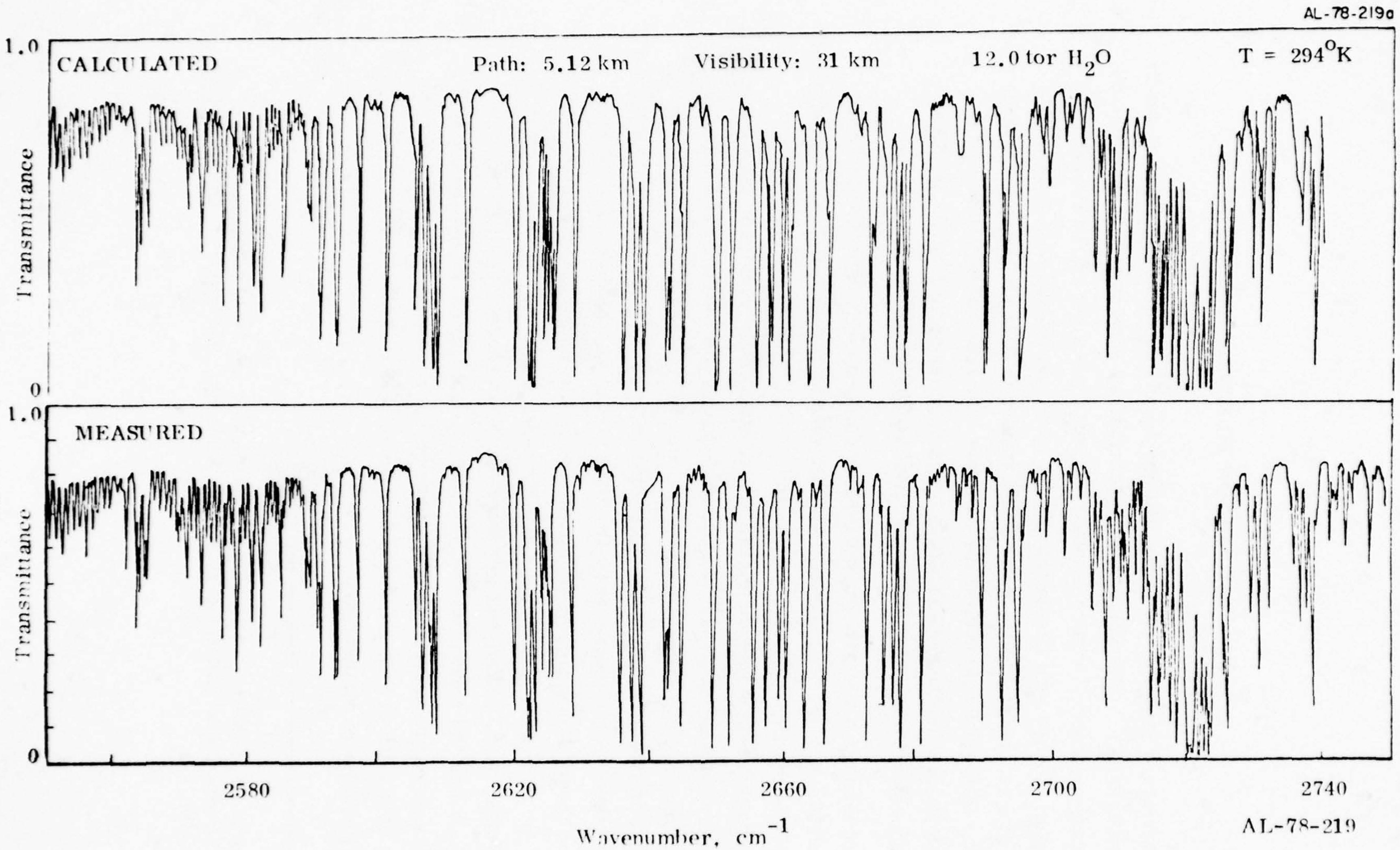

Figure 5. Comparison of NRL Data and a MIDTRAN Calculation for a 5.12 km Horizontal Sea Level Path in the 2550 - 2750 cm^{-1} Spectral Region

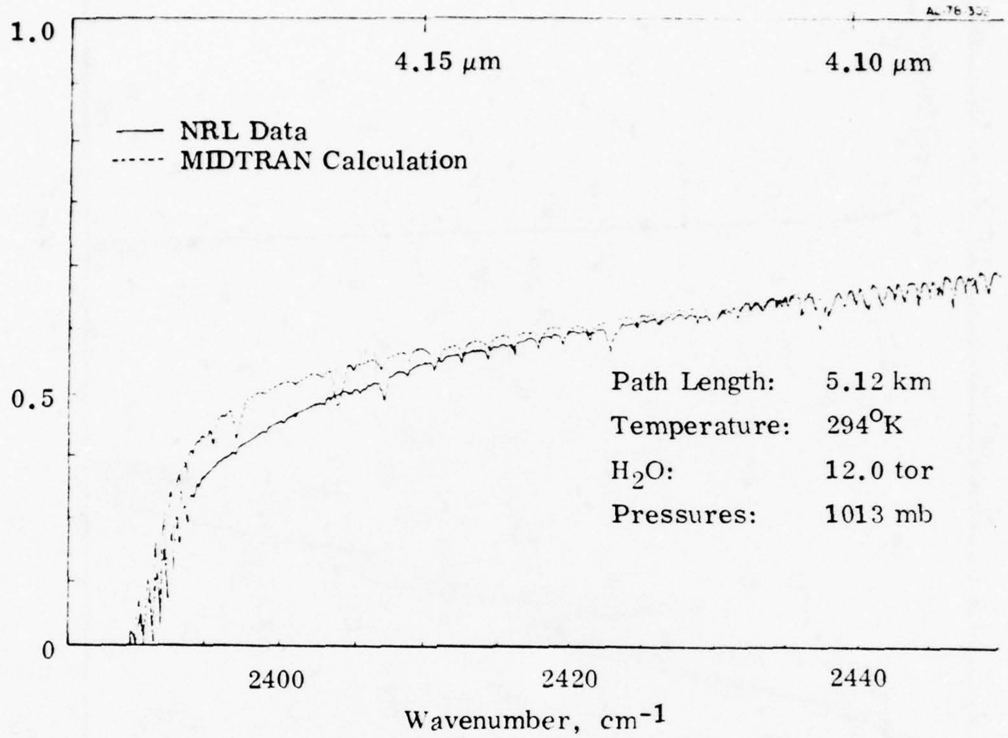

Figure 6. Comparison of NRL Data and MIDTRAN Calculation for a 5.12 km Path at Sea Level From 2385 to 2450 cm^{-1}

Figure 7 shows a comparison of AFGL data and MIDTRAN calculations for the transmittance to space from an altitude of 8.5 km. The transmittance data, which were taken from the AFGL KC135A flying laboratory, are obtained by measuring the solar spectrum and then dividing out the solar irradiance to obtain the atmospheric transmittance. The data were taken in the vicinity of Johnston Island in the Pacific. Local radiosonde data were obtained. The spectral resolution of the AFGL interferometer is 3.8 cm^{-1}.[4]

The MIDTRAN calculation was done at a spectral resolution of 0.01 cm^{-1} and then degraded to 3.8 cm^{-1} using the actual slit function of the AFGL interfereometer. The calculation used local radiosonde data for the lower altitudes and the Tropical

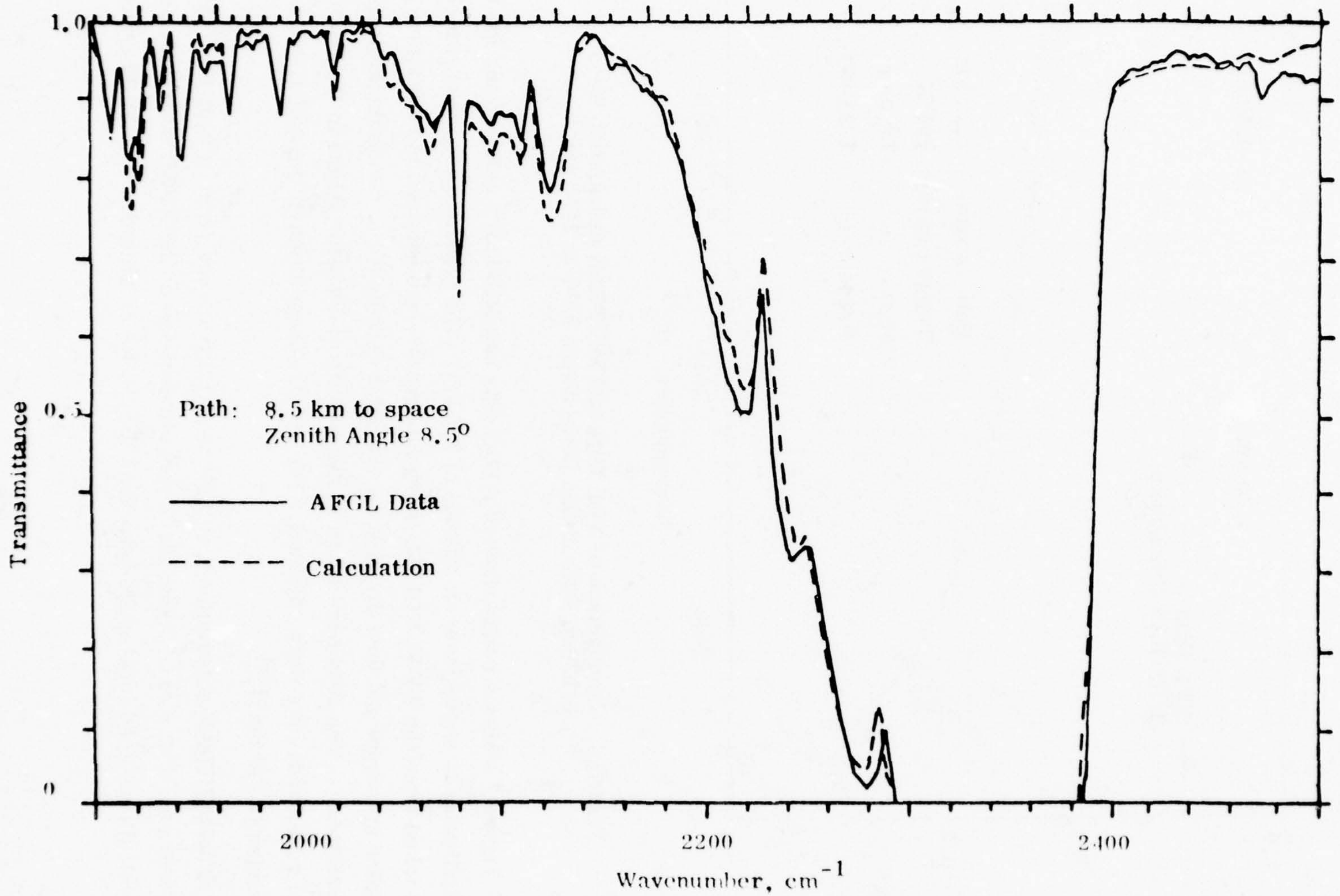

Figure 7. Atmospheric Transmittance Spectra From 8.0 km to Space. The Data Were Taken From the AFGL Flying Laboratory.

model atmosphere[1] for the high altitudes. Table I shows the layers which were used in the calculation. The radiosonde is not able to measure atmospheric water vapor concentrations when the dew point depression temperature becomes less than -30°. Thus, the radiosonde inputs resulted in too much H_2O absorption around 2000 cm^{-1}; the much lower H_2O concentrations listed in Table I bring the calculations and data into better agreement. The ozone profile is that of the Tropical Atmospheric model.

TABLE I - Model Atmosphere Used for the MIDTRAN Calculation Shown in Figure 7. It is Based on Local Radiosonde Data Supplemented by the Tropical Model Atmosphere.

Altitude (km)	Pressure (mb)	Temperature (°C)	H_2O_3 gm/m^3	O_3 gm/m^3
0.	1013.	15.	0.29 (+02)	0.560 (-04)
4.658	581.	0.5	0.74 (-01)	0.457 (-04)
4.968	559.	0.1	0.61 (-01)	0.451 (-04)
5.850	500.	-5.6	0.46 (-01)	0.433 (-04)
6.530	453.	-11.6	0.39 (-01)	0.419 (-04)
6.854	439.	-12.6	0.36 (-01)	0.413 (-04)
7.560	400.	-18.4	0.31 (-01)	0.399 (-04)
9.640	300.	-35.2	0.17 (-01)	0.390 (-04)
10.548	263.	-40.0	0.12 (-01)	0.401 (-04)
10.890	250.	-42.0	0.93 (-02)	0.408 (-04)
12.360	200.	-52.6	0.25 (-02)	0.437 (-04)
14.160	150.	-66.6	0.80 (-03)	0.453 (-04)
14.617	139.	-70.2	0.70 (-03)	0.462 (-04)
16.550	100.	-75.8	0.52 (-03)	0.581 (-04)
16.846	95.	-76.4	0.52 (-03)	0.605 (-04)
18.307	74.	-70.4	0.52 (-03)	0.103 (-03)
18.630	70.	-72.0	0.51 (-03)	0.119 (-03)
20.650	50.	-64.6	0.49 (-03)	0.221 (-03)
22.694	36.	-56.8	0.53 (-03)	0.307 (-03)
23.054	34.	-59.0	0.54 (-03)	0.321 (-03)
23.643	31.	-51.8	0.58 (-03)	0.333 (-03)
23.850	30.	--51.8	0.59 (-03)	0.337 (-03)
26.510	20.	-46.6	0.58 (-03)	0.306 (-03)
28.453	15.	-38.4	0.45 (-03)	0.267 (-03)
29.431	13.	-41.2	0.40 (-03)	0.250 (-03)
31.218	10.	-39.8	0.30 (-03)	0.190 (-03)
40.000	3.05	-19.2	0.43 (-04)	0.410 (-04)
50.000	0.85	-3.2	0.63 (-05)	0.430 (-05)
70.000	0.06	-54.2	0.14 (-06)	0.860 (-07)
100.000	0.00	-63.2	0.10 (-8)	0.430 (-10)
99999.000	0.00	-63.2	0.10 (-10)	0.

5. REFERENCES

1. J. Selby and R. McClatchy, "Atmospheric Transmittance From 0.35 to 28.5 μm; Computer Code LOWTRAN3," Rept. No. AFCRL-TR-75-0255, AFGL/OPI, Hanscom AFB, Mass., May 1975.

2. R. McClatchy, et al., "AFCRL Atmospheric Absorption Line Parameters Compilation," AFCRL-TR-73-0096, AFGL/OPI, Hanscom AFB, Mass., January 1973.

3. D. Kryger and D. Robertson, "MRDA - A Medium Resolution Data Analysis Code for the HP2100 Minicomputer," AFGL-TR-77-0044, AFGL/OPR Hanscom AFB, Massachusetts 01731.

4. B. Sandford, et al., "Aircraft Signatures in the Infrared 1.2 to 5.5 Micron Region," AFGL-TR-76-0133, Air Force Geophysics Laboratory (OPR), Hanscom AFB, Mass., June 1976).

5. D.E. Burch, D.A. Gryvnak, R.R. Patty, and C.E. Bartky, Journal, Optical Society of America, 59, 267, 1969.

6. L.D. Kaplan, M.T. Chahine, J. Susskind, J.E. Searl, Applied Optics, 16, 322, 1977.

7. K. Haught and J. Dowling, "Long Path High Resolution Field Measurements of Absolute Transmission in the 3.5 to 4.0 μm Atmospheric Window," Optics Letters, 1, 121 1977.

APPENDIX A

MIDTRAN PROGRAM LISTING

```
C      PROGRAM MIDTRAN(INPUT,OUTPUT,TAPE5=INPUT,TAPE7,TAPE6=OUTPUT,
C     &TAPE9,TAPE21=120)
C
C
C
       IMPLICIT DOUBLE PRECISION (A-H,O-Z)
       REAL*4 XORG,YORG
       REAL*4 RAD,FNU,TRAN1,TRANS
       REAL*4 SPY1,SPY2
       COMMON Z(34),P(7,34),T(7,34),EH(10,34),WH(7,34),M,NL,RE,CW,CO,PI
       COMMON/BLOCK1/VTAU,TAU1
       COMMON/BLOCK2/RAD,FNU,TRAN1,TRANS
       COMMON/BLOCK3/C1,FRAD
       DIMENSION WO(7,34),HZ1(34),HZ2(6),AHAZE(34),AHZ2(20)
       DIMENSION TR(67),FW(67),FO(67),HZ(2,2),TX(12),VH(10),W(10),E(10)
       DIMENSION C1(2580), C2(1575), C3(540), C4(133), C5(15), C8(102)
       DIMENSION VX(45),C7(45),C7A(45)
       DIMENSION TEMP(66),PRES(66),ALT(66),LYR(66),XPTS(3,66),NUM(6)
       DIMENSION CON(6),SPEC(6,2),PP(9),TTT(9),WW(64,10),WGAS(64)
       DIMENSION WO3(64),WH20(64)
       DIMENSION AK(9,650),FAC5(2)
       DIMENSION TAU(200),VV(650),FAC6(6),TAU1(4000),VTAU(4000)
       DIMENSION FNU(500),TRANS(500)
       DIMENSION FAC2(66),HZZ(6)
       DIMENSION RAD(4000),FRAD(500),TRAN1(4000)
       DIMENSION MAX(2),NEWS(2,10),NEWP(2,10)
       DATA ENDF/-1.0/,NFILES/0/,MAX/0,0/,XORG/0.0/,YORG/0.0/
       DATA CON/0.0,.33E-3,0.0,.28E-6,.75E-7,1.6E-6/
       DATA HZ(1,1)/2H23/,HZ(1,2)/2HKM/,HZ(2,1)/2H 5/,HZ(2,2)/2HKM/
       BLAM(T,V)=1.1989E-12*V**3/(DEXP(1.4388*V/T)-1.0)
       F(A)=DEXP(18.9766-14.9595*A-2.43882*A*A)*A
       F1(Y1,Y2,X1,X2,X)=Y1+(Y2-Y1)*(X-X1)/(X2-X1)
       SPF1(SPY1,SPY2,X1,X2,X)=SPY1+(SPY2-SPY1)*(X-X1)/(X2-X1)
C*************************************************************************
C      PROGRAM  MIDTRAN  CALCULATES THE TRANSMITTANCE OF THE ATMOSPHERE
C      FROM 1800 CM-1 TO 6000 CM-1 (1.67 TO 6.50 MICRONS) AT A VARIABLE
C      SPECTRAL RESOLUTION ON A LINEAR WAVENUMBER SCALE.
C      REFRACTION AND EARTH CURVATURE EFFECTS ARE INCLUDED.    ATMOSPHERE
C      IS LAYERED IN ONE KM. INTERVALS BETWEEN 0 AND 25 KM., 5 KM. INTER-
C      VALS TO 50 KM., A TWENTY KM. INTERVAL TO 70 KM., AND A THIRTY KM.
C      INTERVAL TO 100 KM.
C*************************************************************************
C      PROGRAM ACTIVATED BY SUBMISSION OF TWO SEPARATE SECTIONS OF INPUT.
C
C      FIRST SECTION OF INPUT DATA USES A REPEATING FOUR CARD SEQUENCE
C    CARD 1 MODEL,IHAZE,ITYPE,LEN,JP,IM,M1,M2,M3,NLDAT,RO FORMAT(10I3,F10
C    CARD 2 IRAD,EMIS,TBACK,NTS,NTP,NRS,NRP,XOR,YOR  FORMAT(I10,2F10.3,
C           4I5,2F10.3)
C    CARD 3 H1,H2,ANGLE,RANGE,BETA,VIS                   FORMAT(7F10.3)
C    CARD 4 V1, V2, DV                                   FORMAT(7F10.3)
C
```

```
C     MODEL=1,2,3,4,5 OR 6 SELECTS ONE OF THE FOLLOWING MODEL ATMOSPHEREMA 00520
C     TROPICAL,MIDLATITUDE SUMMER,MIDLATITUDE WINTER,SUBARCTIC SUMMER,  MA 00530
C     SUBARCTIC WINTER,OR THE 1962 U.S.  STANDARD RESPECTIVELY          MA 00540
C     MODEL=-1 TO END FIRST SECTION OF INPUT DATA                       MA 00550
C     MODEL=0 FOR HORIZ. PATH WHEN METEOROL. DATA USED\INSTEAD OF CARD 3MA 00560
C     READ H1,P(MB),T(DEG C),DEW PT.TEMP(DEG C),%REL HUMIDITY,H2O DENSITMA 00570
C     (GM.M-3),O3 DENSITY(GM.M-3), VIS(KM),RANGE(KM) WITH FORMAT 429.   MA 00580
C     MODEL=7 WHEN NEW MODEL ATMOSPHERE(E.G. RADIOSONDE DATA) USED.     MA 00590
C     DATA CARDS ARE READ IN BETWEEN CARDS 2 AND 3, AND SHOULD CONTAIN\ MA 00600
C     ALTITUDE(KM.),PRESSURE,TEMP,DEW PT.TEMP,REL. HUMIDITY,H2O DENSITY,MA 00610
C     O3 DENSITY,AEROSOL NO. DENSITY(CM-3) ACCORDING TO FORMAT 9110     MA 00620
C     NOTE THAT EITHER DEW PT. TEMP.OR REL. HUMIDITY CAN BE USED.       MA 00630
C                                                                       MA 00640
C     M1,M2,M3, ARE USED TO CHANGE TEMP,H2O, AND O3 ALTITUDE PROFILES.  MA 00650
C                                                                       MA 00660
C     IF IHAZE=0 NO AEROSOL SCATTERING IS COMPUTED                      MA 00670
C     IHAZE =1 IF AEROSOL ATTENUATION REQUIRED (THIS IS USED IN         MA 00680
C     CONJUNCTION WITH VISUAL RANGE(SEE CARD 3))                        MA 00690
C     IHAZE = 1 OR 2 ALSO GIVE AEROSOL ATTENUATION FOR 23KM AND 5KM VIS.MA 00700
C     HAZE MODELS RESPECTIVELY IF VIS =0 ON CARD 3                      MA 00710
C                                                                       MA 00720
C     ITYPE=1,2  OR 3 INDICATES THE TYPE OF ATMOSPHERIC PATH            MA 00730
C     ITYPE=3,VERTICAL OR SLANT PATH TO SPACE                           MA 00740
C     ITYPE=2,VERTICAL OR SLANT PATH BETWEEN TWO ALTITUDES              MA 00750
C     ITYPE=1, CORRESPONDS TO A HORIZONTAL (CONSTANT PRESSURE) PATH     MA 00760
                                                                        MA 00770
C     IRAD=1/0, CALCULATE/DONT CALCULATE RADIATION                      MA 00780
C     EMIS=EMISSIVITY OF A BACKGROUND RADIATION SOURCE LOCATED AT THE   MA 00790
C          BEGINNING OF THE ATMOSPHERIC PATH.                           MA 00800
C     TBACK=TEMPERATURE(KELVIN) OF A BACKGROUND RADIATION SOURCE        MA 00810
C           LOCATED AT THE BEGINNING OF THE ATMOSPHERIC PATH.           MA 00820
C     NTS=1/-1, USE GENERAL SLIT FUNCTION AND PLOT/DONT PLOT TRANS.     MA 00830
C        -2/-2, USE SPECIAL AFGL SLIT FUNCTION AND PLOT/DONT PLOT TRANS.MA 00840
C        =3/-3, USE NO SLIT FUNCTION AND PLOT/DONT PLOT TRANS.          MA 00850
C        =0, USE LAST SLIT FUNCTION USED, USE LAST PLOTTING STATUS.     MA 00860
C     NTP=1, PLOT USING CM-1 VS TRANSMITTANCE                           MA 00870
C        =-1, PLOT USING MICRONS VS. TRANSMITTANCE                      MA 00880
C        =0, CONTINUE PLOTTING IN THE LAST UNITS USED.                  MA 00890
C     NRS(SAME AS NTS, BUT FOR RADIATION)                               MA 00900
C     NRP=1, PLOT USING CM-1 VS RADIATION/CM-1                          MA 00910
C        =-1, PLOT USING MICRONS VS RADIATION/MICRONS                   MA 00920
C        =0, CONTINUE PLOTTING IN THE LAST UNITS USED.                  MA 00930
C     XOR= INITIAL HORIZONTAL SETTING IN INCHES FOR PLOT.               MA 00940
C     YOR= INITIAL VERTICAL SETTING IN INCHES FOR PLOT.                 MA 00950
C                                                                       MA 00960
C     H1=OBSERVER ALTITUDE (KM)                                         MA 00970
C     H2=SOURCE  ALTITUDE (KM)                                          MA 00980
C     ANGLE= ZENITH ANGLE AT H1 (DEGREES)                               MA 00990
C     RANGE=PATH LENGTH (KM)                                            MA 01000
C     BETA=EARTH CENTRE ANGLE                                           MA 01010
C     VIS = VISUAL RANGE AT SEA LEVEL (KM)                              MA 01020
C     (IF ITYPE=1 READ H1 AND RANGE;IF ITYPE=3 READ H1 AND ANGLE.       MA 01030
C     IF ITYPE=2 READ H1 AND TWO OTHER PARAMETERS E.G. H2 AND ANGLE)    MA 01040
C                                                                       MA 01050
```

```
C     V1=INITIAL FREQUENCY (WAVENUMBER CM-1 ) INTEGER VALUE              MA Ø1Ø6Ø
C     V2=FINAL FREQUENCY(WAVENUMBER CM-1 ) INTEGER VALUE                 MA Ø1Ø7Ø
C     DV= FREQUENCY INTERVALS AT WHICH TRANSMITTANCE IS CALCULATED       MA Ø1Ø8Ø
C                                                                        MA Ø1Ø9Ø
C     SECOND SECTION OF INPUT DATA USES A REPEATING FORMAT AS FOLLOWS:   MA Ø11ØØ
C   CARD 1 TITLE                                      FORMAT(2ØA4)       MA Ø111Ø
C   CARD 2(A,B,C) SLIT FUNCTION DATA CARDS (VARIES WITH SLIT FUNCTION)   MA Ø112Ø
C     GENERAL SLIT FUNCTION                                              MA Ø113Ø
C   CARD 2A WIDTH,SHIFT,NS                       FORMAT(2F1Ø.5,2I1Ø)     MA Ø114Ø
C   CARD 2B XSS(I),I=1,NS                        FORMAT(8F1Ø.5)          MA Ø115Ø
C   CARD 2C SS(I),I=1,NS                         FORMAT(8F1Ø.5)          MA Ø116Ø
C     SPECIAL AFGL SLIT FUNCTION                                         MA Ø117Ø
C   CARD 2 DELNU,RES,JLO,JHI                     FORMAT(2F1Ø.5,2I1Ø)     MA Ø118Ø
C     NO SLIT FUNCTION                                                   MA Ø119Ø
C   (NO CARD)                                                            MA Ø12ØØ
C     PLOTTING DATA CARDS                                                MA Ø121Ø
C   CARD 3A XTITLE                               FORMAT(2ØA4)            MA Ø122Ø
C   CARD 3B YTITLE                               FORMAT(2ØA4)            MA Ø123Ø
C   CARD 3C XAXIS,XINIT,XSCALE,DXT,NMINX         FORMAT(4E1Ø.4,I1Ø)      MA Ø124Ø
C   CARD 3D YAXIS,YINIT,YSCALE,DYT,NMINY         FORMAT(4E1Ø.4,I1Ø)      MA Ø125Ø
                                                                         MA Ø126Ø
                                                                         MA Ø127Ø
C     TITLE= HEADER FOR PRINTOUT AND TOP TITLE FOR PLOT IF THERE IS ONE MA Ø128Ø
                                                                         MA Ø129Ø
C     WIDTH= SLIT WIDTH TO BE USED ON DATA                               MA Ø13ØØ
C     SHIFT= DISTANCE IN CM-1 BETWEEN SLIT FUNCTION CALCULATION POINTS   MA Ø131Ø
C     NS= NUMBER OF (XSS,SS) PAIRS DEFINING SLIT FUNCTION                MA Ø132Ø
C     XSS= X CO-ORDINATES OF POINTS DEFINING SLIT FUNCTION               MA Ø133Ø
C     SS= Y CO-ORDINATES OF POINTS DEFINING SLIT FUNCTION                MA Ø134Ø
                                                                         MA Ø135Ø
C     DELNU= SAMPLING INTERVAL(CM-1)                                     MA Ø136Ø
C     RES= RESOLUTION(CM-1) OF DATA TO BE PROCESSED                      MA Ø137Ø
C     JLO= BEGINNING CHANNEL(VLOW/DELNU)                                 MA Ø138Ø
C     JHI= ENDING CHANNEL(VHIGH/DELNU)                                   MA Ø139Ø
                                                                         MA Ø14ØØ
C     XTITLE= LABEL FOR HORIZONTAL PLOT UNITS                            MA Ø141Ø
C     YTITLE= LABEL FOR VERTICAL PLOT UNITS                              MA Ø142Ø
C     XAXIS,YAXIS= LENGTH IN INCHES OF THE HORZ., VERT. AXES             MA Ø143Ø
C     XINIT,YINIT= VALUES IN HORZ., VERT. UNITS AT ORIGIN                MA Ø144Ø
C     XSCALE,YSCALE= HORZ., VERT. UNITS/INCH.                            MA Ø145Ø
C     DXT,DYT= HORIZ., VERT. UNITS BETWEEN MAJOR(LABELED) TIC MARKS      MA Ø146Ø
C     NMINX,NMINY= NUMBER OF MINOR TIC MARKS BETWEEN MAJOR TICS          MA Ø147Ø
                                                                         MA Ø148Ø
C     THE SECOND SECTION OF INPUT DATA IS TO BE SET UP IN ACCORDANCE     MA Ø149Ø
C     WITH THE FOLLOWING MATRIX:                                         MA Ø15ØØ
                                                                         MA Ø151Ø
C     NTS(CASE1),NTP(CASE1)  (IE. TRANSMITTANCE,CASE1)                   MA Ø152Ø
C     NTS(CASE2),NTP(CASE2)  (IE. TRANSMITTANCE,CASE2)                   MA Ø153Ø
C                                                                        MA Ø154Ø
C     NTS(CASEN),NTP(CASEN)  (IE. TRANSMITTANCE,CASEN)                   MA Ø155Ø
C     NRS(CASE1),NRP(CASE1)  (IE. RADIATION,CASE1)                       MA Ø156Ø
C     NRS(CASE2),NRP(CASE2)  (IE. RADIATION,CASE2)                       MA Ø157Ø
C                                                                        MA Ø158Ø
C     NRS(CASEN),NRP(CASEN)  (IE. RADIATION,CASEN)                       MA Ø159Ø
                                                                         MA Ø16ØØ
                                                                         MA Ø161Ø
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C     TRANSMITTANCE AND RADIATION CASES ARE DEGRADED AND PLOTTED IN     MA Ø162Ø
C     THE ORDER OF THE ABOVE MATRIX, WITH EACH ROW CORRESPONDING TO A   MA Ø163Ø
C     CARD 1-3 SEQUENCE OF INPUT DATA WHICH MUST BE INCLUDED. THE       MA Ø164Ø
C     FOLLOWING RULES ARE HELPFUL IN DETERMINING THE VALUES WHICH       MA Ø165Ø
C     NTS,NTP,NRS,NRP SHOULD INITIALLY HAVE ON CARD 2 IN THE FIRST      MA Ø166Ø
C     SECTION OF INPUT DATA:                                            MA Ø167Ø
                                                                        MA Ø168Ø
C     CARD 1  TITLE, MUST BE INCLUDED IN EVERY CARD 1-3 SEQUENCE.       MA Ø169Ø
C     CARD 2  MUST BE OMITTED, IF HAVE A ZERO IN THE NTS/NRS            MA Ø17ØØ
C             COLUMN(IE. USE SAME SLIT FUNCTION)                        MA Ø171Ø
C     CARD 2  MUST BE OMITTED, IF THE NEW NTS/NRS VALUE IS EQUAL TO     MA Ø172Ø
C             MINUS THE OLD NTS/NRS VALUE(IE. USE SAME SLIT FUNCTION,   MA Ø173Ø
C             BUT CHANGE PLOTTING STATUS)                               MA Ø174Ø
C     CARD 3  MUST BE OMITTED, IF HAVE A ZERO IN THE NTP/NRP COLUMN(IE. MA Ø175Ø
C             USE THE LAST PLOT PARAMETERS READ IN)                     MA Ø176Ø
C***********************************************************************MA Ø177Ø
C                                                                       MA Ø178Ø
C                                                                       MA Ø179Ø
C                                                                       MA Ø18ØØ
      READ (7,9Ø1Ø) IATM,NL                                             MA Ø181Ø
      READ (7,9Ø2Ø) (HZ1(I),I=1,NL)                                     MA Ø182Ø
      READ (7,9Ø2Ø) (HZ2(I),I=1,5)                                      MA Ø183Ø
      HZ2(6)=HZ1(6)                                                     MA Ø184Ø
                                                                        MA Ø185Ø
      DO 15 J=1,3                                                       MA Ø186Ø
      K2=2*J                                                            MA Ø187Ø
      K1=K2-1                                                           MA Ø188Ø
      DO 1Ø L=1,NL                                                      MA Ø189Ø
      READ (7,9Ø3Ø) Z(L),(P(K,L),T(K,L),WH(K,L),WO(K,L),K=K1,K2)        MA Ø19ØØ
   1Ø CONTINUE                                                          MA Ø191Ø
   15 CONTINUE                                                          MA Ø192Ø
                                                                        MA Ø193Ø
      READ (7,9Ø4Ø) (VX(L),C7(L),C7A(L),L=1,44)                         MA Ø194Ø
      READ (7,9Ø5Ø) (TR(L),FW(L),FO(L),L=1,67)                          MA Ø195Ø
      READ (7,9Ø6Ø) (C1(L),L=1,258Ø)                                    MA Ø196Ø
      READ (7,9Ø6Ø) (C2(L),L=1,1575)                                    MA Ø197Ø
      READ (7,9Ø6Ø) (C3(L),L=1,54Ø)                                     MA Ø198Ø
      READ (7,9Ø7Ø) (C4(L),L=1,133)                                     MA Ø199Ø
      READ (7,9Ø6Ø) (C5(L),L=1,15)                                      MA Ø2ØØØ
      READ (7,9Ø7Ø) (C8(L),L=1,1Ø2)                                     MA Ø2Ø1Ø
      PI=2.Ø*DASIN(1.Ø)                                                 MA Ø2Ø2Ø
      CA=PI/18Ø.                                                        MA Ø2Ø3Ø
      IP=Ø                                                              MA Ø2Ø4Ø
   2Ø CONTINUE                                                          MA Ø2Ø5Ø
                                                                        MA Ø2Ø6Ø
C **********      PROGRAM STOPS HERE     ************                   MA Ø2Ø7Ø
                                                                        MA Ø2Ø8Ø
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      RE=6371.23                                                        MA Ø2Ø9Ø
      IFIND=Ø                                                           MA Ø21ØØ
      READ(5,9Ø1Ø) MODEL,IHAZE,ITYPE,LEN,JP,IM,M1,M2,M3,NLDAT,RO        MA Ø211Ø
      IF(MODEL.GE.Ø) GO TO 27                                           MA Ø212Ø
      CALL LIB(NEWS,NEWP,MAX,NFILES,XORG,YORG)                          MA Ø213Ø
      STOP22                                                            MA Ø214Ø
                                                                        MA Ø215Ø
   27 IF(JP.LT.1) GO TO 28                                              MA Ø216Ø
      WRITE(6,9Ø1Ø) MODEL,IHAZE,ITYPE,LEN,JP,IM,M1,M2,M3,NLDAT,RO       MA Ø217Ø
   28 READ(5,9Ø75) IRAD,EMIS,TBACK,NTS,NTP,NRS,NRP,XOR,YOR              MA Ø218Ø
      IF(JP.LT.1) GO TO 29                                              MA Ø219Ø
      WRITE(6,9Ø75) IRAD,EMIS,TBACK,NTS,NTP,NRS,NRP,XOR,YOR             MA Ø22ØØ
   29 IF(NFILES.NE.Ø) GO TO 3Ø                                          MA Ø221Ø
      XORG=XOR                                                          MA Ø222Ø
      YORG=YOR                                                          MA Ø223Ø
   3Ø M=MODEL                                                           MA Ø224Ø
      IF (M.EQ.1) RE=6378.39                                            MA Ø225Ø
      IF (M.EQ.4) RE=6356.91                                            MA Ø226Ø
      IF (M.EQ.5) RE=6356.91                                            MA Ø227Ø
      NFS1=NFILES+1                                                     MA Ø228Ø
      MAX(1)=NFS1                                                       MA Ø229Ø
      IF(IRAD.EQ.Ø) GO TO 35                                            MA Ø23ØØ
      WRITE(6,9Ø85) EMIS,TBACK                                          MA Ø231Ø
      MAX(2)=NFS1                                                       MA Ø232Ø
      GO TO 45                                                          MA Ø233Ø
   35 XRAD=Ø.Ø                                                          MA Ø234Ø
                                                                        MA Ø235Ø
      DO 4Ø I=1,4ØØØ                                                    MA Ø236Ø
      RAD(I)=Ø.Ø                                                        MA Ø237Ø
   4Ø CONTINUE                                                          MA Ø238Ø
                                                                        MA Ø239Ø
      NRS=-11                                                           MA Ø24ØØ
   45 NEWS(1,NFS1)=NTS                                                  MA Ø241Ø
      NEWS(2,NFS1)=NRS                                                  MA Ø242Ø
      NEWP(1,NFS1)=NTP                                                  MA Ø243Ø
      NEWP(2,NFS1)=NRP                                                  MA Ø244Ø
      IF(RO.NE.Ø.Ø) RE=RO                                               MA Ø245Ø
      IF(M.EQ.7.AND.IM.NE.Ø)GO TO 7Ø                                    MA Ø246Ø
      IF (MODEL.EQ.Ø) GO TO 7Ø                                          MA Ø247Ø
   5Ø READ(5,9Ø8Ø)  H1,H2,ANGLE,RANGE,BETA,VIS                          MA Ø248Ø
      WRITE(6,9Ø9Ø) H1,H2,ANGLE,RANGE,BETA,VIS                          MA Ø249Ø
      X1=RE+H1                                                          MA Ø25ØØ
      IF (ITYPE.EQ.3) GO TO 11Ø                                         MA Ø251Ø
      IF (ITYPE.EQ.1) GO TO 16Ø                                         MA Ø252Ø
      X2=RE+H2                                                          MA Ø253Ø
      IF (RANGE.EQ.Ø.) GO TO 13Ø                                        MA Ø254Ø
      WRITE(6,91ØØ)  H1,H2,ANGLE,RANGE,BETA,VIS                         MA Ø255Ø
      IF (H2.EQ.Ø.AND.ANGLE.NE.Ø) GO TO 6Ø                              MA Ø256Ø
      ANGLE=DACOS(Ø.5*((H2-H1)*(1.+X2/X1)/RANGE-RANGE/X1))/CA           MA Ø257Ø
      GO TO 15Ø                                                         MA Ø258Ø
   6Ø X2=DSQRT((X1/RANGE+RANGE/X1+2.Ø*DCOS(ANGLE*CA))*X1*RANGE)         MA Ø259Ø
      H2=X2-RE                                                          MA Ø26ØØ
      GO TO 15Ø                                                         MA Ø261Ø
   7Ø CONTINUE                                                          MA Ø262Ø
      IF(NLDAT.LE.Ø)NLDAT=1                                             MA Ø263Ø
                                                                        MA Ø264Ø
                                                                        MA Ø265Ø
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      DO 100 L=1,NLDAT                                                  MA 02660
      AHAZE(L)=0.0                                                      MA 02670
      IF(M.EQ.0) READ(5,9110) H1,P(7,1),TMP,DP,RH,WH(7,L),WO(7,L),VIS,  MA 02680
     X RANGE                                                            MA 02690
      IF(M.EQ.0) WRITE(6,9115) H1,P(7,1),TMP,DP,RH,WH(7,L),WO(7,L),VIS, MA 02700
     X RANGE                                                            MA 02710
      IF(M.GT.0) READ(5,9110) Z(L),P(7,L),TMP,DP,RH,WH(7,L),WO(7,L),    MA 02720
     X AHAZE(L)                                                         MA 02730
      IF(M.EQ.0)Z(L)=H1                                                 MA 02740
      J=IFIX(Z(L)+1.0E-6)+1.                                            MA 02750
      IF(Z(L).GE.25.0) J=(Z(L)-25.0)/5.0+26.                            MA 02760
      IF(Z(L).GE.50.0) J=(Z(L)-50.0)/20.0+31.                           MA 02770
      IF(Z(L).GE.70.0) J=(Z(L)-70.0)/30.0+32.                           MA 02780
      IF(J.GT.33)J=33                                                   MA 02790
      FAC=Z(L)-FLOAT(J-1)                                               MA 02800
      IF(J.LT.26) GO TO 80                                              MA 02810
      FAC=(Z(L)-5.0*FLOAT(J-26)-25.)/5.                                 MA 02820
      IF(J.GE.31) FAC=(Z(L)-50.0)/20.                                   MA 02830
      IF(J.GE.32) FAC=(Z(L)-70.0)/30.                                   MA 02840
      IF(FAC.GT.1.0) FAC=1.0                                            MA 02850
   80 K=J+1                                                             MA 02860
      T(7,L)=TMP+273.15                                                 MA 02870
      IF(M1.GT.0)T(7,L)=T(M1,J)*(T(M1,K)/T(M1,J))**FAC                  MA 02880
      TT=273.15/T(7,L)                                                  MA 02890
      IF(RH.LE.0.0) TT=273.15/(273.15+DP)                               MA 02900
      IF(WH(7,L).LE.0.0) WH(7,L)=F(TT)                                  MA 02910
      IF(M2.GT.0)WH(7,L)=WH(M2,J)*(WH(M2,K)/WH(M2,J))**FAC              MA 02920
      IF(RH.GT.0.0) WH(7,L)=0.01*RH*WH(7,L)                             MA 02930
      IF(M3.GT.0)WO(7,L)=WO(M3,J)*(WO(M3,K)/WO(M3,J))**FAC              MA 02940
      IF(Z(L).GE.5.0)GO TO 90                                           MA 02950
      IF(AHAZE(L).EQ.0.0)AHZ2(L)=HZ2(J)*(HZ2(K)/HZ2(J))**FAC            MA 02960
   90 IF(AHAZE(L).EQ.0.0)AHAZE(L)=HZ1(J)*(HZ1(K)/HZ1(J))**FAC           MA 02970
      IF(MODEL.EQ.0)GO TO 160                                           MA 02980
      IF(L.EQ.1) WRITE(6,9120)                                          MA 02990
      WRITE(6,9113) Z(L),P(7,L),TMP,DP,RH,WH(7,L),WO(7,L),AHAZE(L)      MA 03000
  100 CONTINUE                                                          MA 03010
                                                                        MA 03020
                                                                        MA 03030
      IM=0                                                              MA 03040
      NL=NLDAT                                                          MA 03050
      M1=0                                                              MA 03060
      M2=0                                                              MA 03070
      M3=0                                                              MA 03080
                                                                        MA 03090
C     NOTE THAT Z(I) MAY NOT CORRESPOND TO THE VALUES GIVEN FOR STANDARDMA 03100
C     MODEL ATMOSPHERES                                                 MA 03110
                                                                        MA 03120
      GO TO 50                                                          MA 03130
  110 IF (RANGE.GT.0.0) GO TO 120                                       MA 03140
      IF (H2.GT.0.0.AND.H2.LT.H1) IFIND=1                               MA 03150
      GO TO 160                                                         MA 03160
  120 ITYPE=2                                                           MA 03170
      BETA=DACOS(0.5*(RANGE*RANGE/(X1*X2)-X2/X1-X1/X2))/CA              MA 03180
  130 IF (BETA.EQ.0.) GO TO 140                                         MA 03190
      IFIND=1                                                           MA 03200
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      BET=CA*BETA                                                        MA Ø321Ø
      X2=RE+H2                                                           MA Ø322Ø
      ANGLE=DATAN(X2*DSIN(BET)/(X2*DCOS(BET)-X1))/CA                     MA Ø323Ø
      RANGE=X2*DSIN(BET)/DSIN(ANGLE*CA)                                  MA Ø324Ø
      BET=BETA                                                           MA Ø325Ø
      GO TO 16Ø                                                          MA Ø326Ø
  14Ø RANGE=(X2/X1)**2-(DSIN(ANGLE*CA))**2                               MA Ø327Ø
      IF (RANGE.GE.Ø.Ø) RANGE=X1*(DSQRT(RANGE)-DABS(DCOS(ANGLE*CA)))     MA Ø328Ø
  15Ø IF (ANGLE.NE.Ø..OR.ANGLE.NE.18Ø.) BET=DASIN(RANGE*DSIN(ANGLE*CA)/  MA Ø329Ø
     &X2)                                                                MA Ø33ØØ
      IF (ANGLE.LT.Ø.) ANGLE=ANGLE+PI                                    MA Ø331Ø
      IF (RANGE.LT.Ø.Ø) RANGE=-RANGE                                     MA Ø332Ø
      BET=BET/CA                                                         MA Ø333Ø
      WRITE(6,91ØØ)  H1,H2,ANGLE,RANGE,BET,VIS                           MA Ø334Ø
  16Ø CONTINUE                                                           MA Ø335Ø
      SUMA=Ø.                                                            MA Ø336Ø
                                                                         MA Ø337Ø
C***   DV FOR LOWTRAN --- DVM FOR MIDTRAN                                MA Ø338Ø
                                                                         MA Ø339Ø
      DV=5.Ø                                                             MA Ø34ØØ
      READ(5,9Ø8Ø) V1,V2,DVM                                             MA Ø341Ø
      IF(JP.GE.1) WRITE(6,9Ø8Ø) V1,V2,DV,DVM                             MA Ø342Ø
      IF (ITYPE.EQ.1) WRITE(6,913Ø)  H1,RANGE                            MA Ø343Ø
      IF (ITYPE.EQ.2) WRITE(6,914Ø) H1,H2,ANGLE                          MA Ø344Ø
      IF (ITYPE.EQ.3) WRITE(6,915Ø) H1,ANGLE                             MA Ø345Ø
      IF (MODEL.EQ.Ø) M=7                                                MA Ø346Ø
      IF(VIS.GT.Ø.Ø) WRITE(6,916Ø)VIS                                    MA Ø347Ø
      IF(VIS.LT.2.Ø.AND.VIS.GT.Ø.Ø) WRITE(6,9165)                        MA Ø348Ø
      IF (M.EQ.1) WRITE(6,917Ø) M                                        MA Ø349Ø
      IF (M.EQ.2) WRITE(6,918Ø) M                                        MA Ø35ØØ
      IF (M.EQ.3) WRITE(6,919Ø) M                                        MA Ø351Ø
      IF (M.EQ.4) WRITE(6,92ØØ) M                                        MA Ø352Ø
      IF (M.EQ.5) WRITE(6,921Ø) M                                        MA Ø353Ø
      IF (M.EQ.6) WRITE(6,922Ø) M                                        MA Ø354Ø
      IF (IHAZE.EQ.Ø.) WRITE(6,923Ø)                                     MA Ø355Ø
      IF(VIS.LE.Ø.Ø.AND.IHAZE.GT.Ø) WRITE(6,9235) IHAZE,(HZ(IHAZE,L),    MA Ø356Ø
     X L=1,2)                                                            MA Ø357Ø
      AVW=1ØØØØ./V1                                                      MA Ø358Ø
      ALAM=1ØØØØ./V2                                                     MA Ø359Ø
      WRITE(6,924Ø) V1,V2,DV,ALAM,AVW                                    MA Ø36ØØ
      AVW=Ø.5E-4*(V1+V2)                                                 MA Ø361Ø
      AVW=AVW*AVW                                                        MA Ø362Ø
      CO=77.46+.459*AVW                                                  MA Ø363Ø
      CW=43.487-Ø.3473*AVW                                               MA Ø364Ø
      IF (IFIND.EQ.1) GO TO 21Ø                                          MA Ø365Ø
  17Ø IF (IFIND.EQ.1) CALL ANGL (H1,H2,ANGLE,BETA,LEN,NLDAT)             MA Ø366Ø
      IFIND=Ø                                                            MA Ø367Ø
      IF(MODEL.NE.Ø.OR.ITYPE.NE.1) WRITE(6,925Ø)                         MA Ø368Ø
      IF (ITYPE.EQ.1) GO TO 21Ø                                          MA Ø369Ø
                                                                         MA Ø37ØØ
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      DO 180 K=1,10
      VH(K)=0.0
  180 CONTINUE

      BETA=0.0
      SR=0 0
      IP=0

C****  NOW DEFINE CONSTANT PRESSURE PATH QUANTITES  EH(1-8)

      Y=CA*ANGLE
      SPHI=DSIN(Y)
      R1=(RE+H1)*SPHI
      IF (H1.GT.Z(NL)) GO TO 190
      GO TO 210
  190 X=(RE+Z(NL))/(RE+H1)
      IF (SPHI.GT.X) GO TO 200
      H1=Z(NL)
      L1=NL
      SPHI=SPHI/X
      ANGLE=180.0-DASIN(SPHI)/CA
      R1=(RE+H1)*SPHI
      GO TO 210
  200 HMIN=R1-RE
      WRITE(6,9260)  HMIN

C     ****    TEMPORARY STOP    ****

      STOP 5


  210 DO 240 L=1,NL
      PS=P(M,L)/1013.0
      TS=273.15/T(M,L)
      IF(M1.GT.0.AND.M.LT.7)TS=273.15/T(M1,L)
      X=PS*TS
      PT=PS*DSQRT(TS)
      D=0.1*WH(M,L)
      IF(M2.GT.0.AND.M.LT.7) D=0.1*WH(M2,L)
      EH(1,L) = .0125*D
      EH(2,L)=X*PT**0.75
      EH(4,L)=0.8*PT*X
      PPW=4.56E-5*D*273.15/TS
      EH(5,L)=D*PPW*DEXP(6.08*(296.0/T(M,L)-1.0))
     &+.002*D*(PS-PPW)
      EH(10,L)=D*(PPW+0.12*(PS-PPW))*DEXP(4.56*(296.0/T(M,L)-1.0))
      EH(6,L)=X
      HAZE=HZ1(L)
      IF(M.EQ.7) HAZE=AHAZE(L)
      IF(Z(L).GE.5.0) GO TO 220
       IF(M.EQ.7.AND.IHAZE.EQ.2) HAZE=HZ2(L)
      IF(IHAZE.EQ.2.AND.M.EQ.7)HAZE=AHZ2(L)
      IF(VIS.LE.0.0) GO TO 220
      IF(M.EQ.7)HAZE= 6.389*((HZ2(L)-HZ1(L))/VIS+HZ1(L)/5.0-HZ2(L)/23.0)
      IF (M.NE.7) GO TO 220
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      HAZE=6.389*((AHZ2(L)-AHAZE(L))/VIS+AHAZE(L)/5.ØDØ-AHZ2(L)/23.Ø)    MA Ø4260
 22Ø  IF(HAZE.LT.Ø.Ø) HAZE=Ø.Ø                                           MA Ø4270
      EH(7,L)=3.5336E-4*HAZE                                             MA Ø4280
      IF(MODEL.EQ.7) EH(7,L)=HAZE/AHAZE(1)                               MA Ø4290
      EH(8,L)=.467E-3*WO(M,L)                                            MA Ø4300
      IF(M3.GT.Ø.AND.M.LT.7) EH(8,L)=.467E-3*WO(M3,L)                    MA Ø4310
      EH(3,L)=EH(8,L)                                                    MA Ø4320
      EH(9,L)=1.Ø                                                        MA Ø4330
      REF=1.ØE-6*(CO*X*1Ø13.Ø/273.15-PPW*CW)                             MA Ø4340
      L1=1                                                               MA Ø4350
      IF (L.EQ.NL) GO TO 23Ø                                             MA Ø4360
      IF (MODEL.EQ.Ø.AND.L.GE.1) GO TO 35Ø                               MA Ø4370
      T2=T(M,L+1)                                                        MA Ø4380
      W2=WH(M,L+1)                                                       MA Ø4390
      IF(M1.GT.Ø)T2=T(M1,L+1)                                            MA Ø4400
      IF(M2.GT.Ø)W2=WH(M2,L+1)                                           MA Ø4410
      PPW=4.56E-6*W2*T2                                                  MA Ø4420
      EH(9,L)=Ø.5*(REF+1.ØE-6*(CO*P(M,L+1)/T2-PPW*CW))                   MA Ø4430
 23Ø  IF (L.EQ.NL) EH(9,L)=Ø.Ø                                           MA Ø4440
      IF (H1.GE.Z(L)) L1=L                                               MA Ø4450
      IF(IFIND.EQ.Ø)  WRITE(6,927Ø)L,Z(L),(EH(K,L),K=1,1Ø),REF           MA Ø4460
      EH(9,L)=EH(9,L)+1.Ø                                                MA Ø4470
 24Ø  CONTINUE                                                           MA Ø4480
                                                                         MA Ø4490
                                                                         MA Ø4500
 25Ø  IF (IFIND.EQ.1) GO TO 17Ø                                          MA Ø4510
      IP=-1                                                              MA Ø4520
      IK=Ø                                                               MA Ø4530
      X1=H1                                                              MA Ø4540
      CALL POINT (H1,YN,L,NP1,TX,IP)                                     MA Ø4550
      T1=TX(11)                                                          MA Ø4560
      P1=TX(12)                                                          MA Ø4570
      L1=L                                                               MA Ø4580
      TX1=TX(9)                                                          MA Ø4590
                                                                         MA Ø4600
      DO 26Ø K=1,1Ø                                                      MA Ø4610
      E(K)=TX(K)                                                         MA Ø4620
 26Ø  CONTINUE                                                           MA Ø4630
                                                                         MA Ø4640
      LBR=Ø                                                              MA Ø4650
      IF (ITYPE.EQ.1) GO TO 35Ø                                          MA Ø4660
      IF (ITYPE.EQ.3) H2=Z(NL)                                           MA Ø4670
      IF (ANGLE.GT.9Ø.Ø) GO TO 38Ø                                       MA Ø4680
 27Ø  IF (ANGLE.GT.9Ø.Ø.AND.NP1.GT.Ø) L1=L1+1                            MA Ø4690
      L2=NL                                                              MA Ø4700
      IF (ITYPE.EQ.3) GO TO 28Ø                                          MA Ø4710
      CALL POINT (H2,YN,L,NP,TX,IP)                                      MA Ø4720
      T2=TX(11)                                                          MA Ø4730
      P2=TX(12)                                                          MA Ø4740
      L2=L                                                               MA Ø4750
      IF (NP.GT.Ø) L2=L2-1                                               MA Ø4760
      EH(1Ø,L1)=E(1Ø)                                                    MA Ø4770
                                                                         MA Ø4780
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  280 DO 290 K=1,8
      EH(K,L1)=E(K)
      IF (ITYPE.EQ.3) GO TO 290
      EH(K,L2+1)=TX(K)
  290 CONTINUE

      IF(ITYPE.NE.3)EH(10,L2+1)=TX(10)
      IF (L1.EQ.L2) TX1=TX1+YN-EH(9,L1)

C****  NOW DEFINE VERTICAL PATH QUANTITIES VH(1-8)

      WRITE(6,9280)


      DO 340 L=L1,L2
      X1=Z(L)
      X2=Z(L+1)
      IF (L.EQ.L1) X1=H1
      IF (L.EQ.L2) X2=H2
      DZ=X2-X1
      IF (L.EQ.NL) DZ=Z(L)-Z(L-1)
      DS=DZ

C*****  UPWARD TRAJECTORY

      RX=(RE+X1)/(RE+X2)
      THETA=DASIN(SPHI)/CA
      PHI=DASIN(SPHI*RX)/CA
      BET=THETA-PHI
      SALP=RX*SPHI
      IF (SPHI.GT.1.E-10) DS=(RE+X2)*DSIN(BET*CA)/SPHI
      BETA=BETA+BET
      PSI=BETA+PHI-ANGLE
      PHI=180.-PHI
      SR=SR+DS
      LL=L-L1+LBR+1

      DO 330 K=1,10
      EV=DS*EH(K,L)
      IF (L.EQ.NL) GO TO 300
      IF (EH(K,L).EQ.0.0.OR.EH(K,L+1).EQ.0.0) GO TO 310
      IF (EH(K,L).EQ.EH(K,L+1)) GO TO 320
      A1=EH(K,L)
      B1=EH(K,L+1)
      EV=DS*(EH(K,L)-EH(K,L+1))/DLOG(EH(K,L)/EH(K,L+1))
      GO TO 320
  300 IF (EH(K,L).EQ.0.0) GO TO 310
      IF (EH(K,L-1).EQ.0.0) GO TO 310
      IF (EH(K,L).EQ.EH(K,L-1)) GO TO 320
      A2=EH(K,L)
      B2=EH(K,L-1)
      EV=EV/DLOG(EH(K,L-1)/EH(K,L))
      GO TO 320
```

```
  31Ø EV=Ø.
  32Ø VH(K)=VH(K)+EV
      WW(LL,K)=EV
  33Ø CONTINUE

      LYR(LL)=L
      ALT(LL)=X1
      TEMP(LL)=DSQRT(T(M,L)*T(M,L+1))
      PRES(LL)=DSQRT(P(M,L)*P(M,L+1))
      WRITE(6,929Ø)L,X1,(VH(K),K=1,8),PSI,PHI,BETA,THETA,SR
      IF (L.GE.NL) GO TO 34Ø
      IF (L+1.EQ.L2) EH(9,L+1)=YN
      IF (L.EQ.L1) EH(9,L)=TX1
      RN=EH(9,L+1)/EH(9,L)
      SPHI=SPHI*RX/RN
      IF (SALP.GE.RN) SPHI=SALP
  34Ø CONTINUE


      LBR=L2-L1+LBR+1
      GO TO 66Ø

C**** HORIZONTAL PATH

  35Ø DO 36Ø K=1,1Ø
      W(K)=RANGE*EH(K,1)
      VH(K)=W(K)
      IF (MODEL.GT.Ø) W(K)=RANGE*TX(K)
      WW(1,K)=W(K)
  36Ø CONTINUE

      LMAX=1
      LYR(1)=L1
      TEMP(1)=T(M,1)
      PRES(1)=P(M,1)
      ALT(1)=Z(1)
      IF(MODEL.EQ.Ø) GO TO 37Ø
      TEMP(1)=T1
      PRES(1)=P1
      ALT(1)=H1
  37Ø LBR=1
      GO TO 68Ø
  38Ø CONTINUE

C****   DOWNWARD TRAJECTORY

      K2=Ø
      IF (NP1.EQ.1) L1=L1-1
      L2=L1+1
      YN1=YN
      LØ=L1+1
      IF (H2.GT.Z(L1+1).OR.H1.EQ.H2) GO TO 4ØØ
      IF (NP1.EQ.1.AND.H2.GE.Z(L1+1)) GO TO 4ØØ
      CALL POINT (H2,YN,L,NP2,TX,IP)
```

```
      T2=TX(11)
      P2=TX(12)

      DO 39Ø K=1,1Ø
      W(K)=TX(K)
39Ø   CONTINUE

      TX2=TX(9)
      YN2=YN
      IF (H2.LT.H1) H=H2
      L2=L
      IF (L1.EQ.L2) TX2=TX1+YN2-EH(9,L)
      IF (H2.GT.H1) TX1=TX2
      IF (L1.EQ.L2.AND.H2.LT.H1) YN1=TX2
4ØØ   AØ=(RE+H1)*SPHI*YN1
      IF (H2.GE.H1) YN2=YN1

      DO 41Ø L=1,L1
      HMIN=AØ/EH(9,L)-RE
      IF (L.EQ.L1) HMIN=AØ/YN1-RE
      LMIN=L
      IF (HMIN.LE.Z(L+1)) GO TO 42Ø
41Ø   CONTINUE

42Ø   X=HMIN
      IF (HMIN.LE.Ø) GO TO 44Ø
      CALL POINT (X,YN,L,NP,TX,IP)
      TMIN=TX(11)
      PMIN=TX(12)
      LMIN=N
      TX3=TX(9)
      IF (L2.EQ.L.OR.L1.EQ.L) TX3=YN2+TX(9)-EH(9,L)
      IF(TX3.LT.Ø.Ø)TX3=TX(9)
      IF (L1.EQ.L.AND.H2.GE.H1) GO TO 43Ø
      HMIN=AØ/TX3-RE
      IF (DABS(X-HMIN).GT.Ø.ØØØ1) GO TO 42Ø
43Ø   IF (L1.EQ.L.AND.H2.GE.H1) YN1=TX3

      IF (L2.EQ.L.AND.L1.LE.L2) YN2=TX3
      IF (H2.GE.H1) TX2=TX3
      IF (H2.GE.H1) L2=L
      IF (H2.GE.H1.OR.H2.LT.HMIN) H=HMIN
      WRITE(6,93ØØ)  HMIN
      IF(H2.LT.HMIN)L2=L
      IF (H2.LT.HMIN) WRITE(6,93Ø5) HMIN
      GO TO 45Ø
44Ø   WRITE(6,93ØØ) HMIN
      IF (H2.LT.H1) GO TO 45Ø
      IF (ITYPE.EQ.3.OR.H2.GE.H1) WRITE(6,931Ø)
      ITYPE=2
      TX2=EH(9,1)
      LMIN=Ø
      L2=1
      H2=Ø.Ø
      H=Ø.3
```

```
C****  NOW DEFINE VERTICAL PATH QUANTITIES VH(1-8)

  45Ø WRITE(6,928Ø)
      L=LØ
      LL=LBR


      DO 51Ø I=1,NL
      LL=LL+1
      L=L-1
      REF=EH(9,L)
      IF (I.EQ.1) REF=YN1
      IF (I.EQ.1.AND.K2.EQ.1) REF=YN2
      IF (L.EQ.L2.AND.K2.EQ.Ø) REF=TX2
      IF (I.NE.1) X1=Z(L+1)
      X2=Z(L)
      IF (L.EQ.L2.AND.K2.EQ.Ø) X2=H
      IF (L.EQ.LMIN.AND.K2.EQ.1) X2=HMIN
      HM=(RE+X1)*SPHI-RE
      IF (HM.GT.Z(L).AND.HM.GT.X2) X2=HM
      RX=(RE+X1)/(RE+X2)
      DS=X1-X2
      ALP=9Ø.Ø
      THET=DASIN(SPHI)/CA
      SALP=RX*SPHI
      IF (DABS(X2-HM).GT.1.ØE-5) ALP=DASIN(SALP)/CA
      BET=ALP-THET
      IF (SPHI.GT.1.ØE-1Ø) DS=(RE+X2)*DSIN(BET*CA)/SPHI
      THETA=18Ø.Ø-THET
      BETA=BETA+BET
      PSI=BETA-ALP-ANGLE+18Ø.Ø
      SR=SR+DS

      DO 5ØØ K=1,1Ø
      AL=EH(K,L)
      BL=EH(K,L+1)
      IF (L.EQ.L1) BL=E(K)
      IF (L.EQ.L2.AND.H2.LT.H1.AND.H2.GT.Ø.Ø) AL=W(K)
      IF (L.EQ.LMIN.AND.H2.GE.H1) AL=TX(K)
      IF (L.EQ.LMIN.AND.DABS(H2-HM).LT.1.ØE-5) AL=TX(K)
      IF (K2.EQ.Ø) GO TO 46Ø
      IF (L.EQ.L2) BL=W(K)
      IF (L.EQ.LMIN) AL=TX(K)
  46Ø IF (AL.EQ.Ø.Ø.OR.BL.EQ.Ø.Ø) GO TO 48Ø
      IF (AL.EQ.BL) GO TO 47Ø
      EV=DS*(AL-BL)/DLOG(AL/BL)
      GO TO 49Ø
  47Ø EV=DS*AL
      GO TO 49Ø
  48Ø EV=Ø.Ø
  49Ø VH(K)=VH(K)+EV
      WW(LL,K)=EV
  5ØØ CONTINUE
```

```
      LBR=LL
      LYR(LL)=L
      ALT(LL)=X1
      TEMP(LL)=DSQRT(T(M,L)*T(M,L+1))
      PRES(LL)=DSQRT(P(M,L)*P(M,L+1))
      WRITE(6,929Ø) L,X1,(VH(K),K=1,8),PSI,ALP,BETA,THETA,SR
      IF (L.EQ.L2.AND.H2.GE.H1) GO TO 6ØØ
      IF (L.EQ.LMIN.AND.K2.EQ.1) GO TO 54Ø
      IF (L.NE.1) RN=REF/EH(9,L-1)
      IF (L.EQ.L2+1) RN=REF/TX2
      IF (L.EQ.L2.AND.K2.EQ.Ø) RN=REF/YN2
      IF (L.EQ.(LMIN+1).AND.K2.EQ.1) RN=REF/TX3
      IF (SALP.GE.RN) RN=1.Ø
      SPHI=SALP*RN
      IF (L.EQ.L2.AND.K2.EQ.Ø) GO TO 52Ø
 51Ø  CONTINUE


 52Ø  TEMP(LL)=DSQRT(T2*T(M,L))
      PRES(LL)=DSQRT(P2*P(M,L))
      IF (HMIN.LE.Ø) GO TO 66Ø
      IF (LEN.EQ.Ø) WRITE(6,932Ø)
      IF (LEN.EQ.Ø) GO TO 66Ø
      IF (LEN.EQ.1) WRITE(6,933Ø)
      K2=1
      X1=X2
      IF (DABS(X1-HMIN).LE.Ø.ØØ1) GO TO 66Ø
      H=HMIN
      L=L2+1
      IF (NP2.EQ.1) L=L-1
      B=BETA
      PH=18Ø.Ø-DASIN(SPHI)/CA
      TS=SR
      PS=PSI

      DO 53Ø K=1,1Ø
      E(K)=VH(K)
 53Ø  CONTINUE

      LSTORE=LBR
      GO TO 45Ø

 54Ø  TEMP(LL)=DSQRT(TMIN*T(M,L+1))
      PRES(LL)=DSQRT(PMIN*P(M,L+1))
      BETA=2.*BETA-B
      PSI=2.*PSI-PS
      SR=2.*SR-TS

C      LONG PATH  TAKEN

      PHI=PH

      DO 55Ø K=1,1Ø
      VH(K)=2.*VH(K)-E(K)
 55Ø  CONTINUE
```

```
C***DOWNWARD H2.GT.H1--LONG PATH STORAGE

      LLMIN=LBR+1
      LBR=2*LBR-LSTORE

      DO 590 LL=LLMIN,LBR
      LMAP=LBR-LL+LSTORE
      ALT(LL)=ALT(LMAP+2)
      IF (LL.EQ.LLMIN) GO TO 560
      TEMP(LL)=DSQRT(T(M,LMAP+1)*T(M,LMAP+2))
      PRES(LL)=DSQRT(P(M,LMAP+1)*P(M,LMAP+2))
      GO TO 570
  560 ALT(LL)=HMIN
      PRES(LL)=DSQRT(PMIN*P(M,LMAP+2))
      TEMP(LL)=DSQRT(TMIN*T(M,LMAP+2))
  570 CONTINUE

      DO 580 K=1,10
      WW(LL,K)=WW(LMAP+1,K)
  580 CONTINUE

  590 CONTINUE

      GO TO 660
  600 TEMP(LL)=DSQRT(T1*T(M,L))
      PRES(LL)=DSQRT(P1*P(M,L))

      DO 610 K=1,10
      VH(K)=2.0*VH(K)
  610 CONTINUE

C***DOWNWARD H1.LT.H2---H1.NE.HMIN

      LLMIN=LBR+1
      LBR=2*LBR

      DO 650 LL=LLMIN,LBR
      LMAP=LBR-LL
      ALT(LL)=ALT(LMAP+2)
      IF (LL.EQ.LLMIN) GO TO 620
      TEMP(LL)=DSQRT(T(M,LMAP+1)*T(M,LMAP+2))
      PRES(LL)=DSQRT(P(M,LMAP+1)*P(M,LMAP+2))
      GO TO 630
  620 ALT(LL)=HMIN
      TEMP(LL)=DSQRT(TMIN*T(M,LMAP+2))
      PRES(LL)=DSQRT(PMIN*P(M,LMAP+2))
  630 LYR(LL)=LYR(LMAP+1)

      DO 640 K=1,10
      WW(LL,K)=WW(LMAP+1,K)
  640 CONTINUE

  650 CONTINUE
```

```
      BETA=2.Ø*BETA                                                     MA Ø8Ø6Ø
      SR=2.Ø*SR                                                         MA Ø8Ø7Ø
      IF (H2.EQ.H1) GO TO 66Ø                                           MA Ø8Ø8Ø
      RN=TX1/YN1                                                        MA Ø8Ø9Ø
      SPHI=DSIN(ANGLE*CA)                                               MA Ø81ØØ
      IF (SPHI.LT.RN) SPHI=SPHI/RN                                      MA Ø811Ø
      GO TO 27Ø                                                         MA Ø812Ø
  66Ø CONTINUE                                                          MA Ø813Ø
      WRITE(6,9Ø8Ø) HM                                                  MA Ø814Ø
                                                                        MA Ø815Ø
      DO 67Ø K=1,1Ø                                                     MA Ø816Ø
      W(K)=VH(K)                                                        MA Ø817Ø
  67Ø CONTINUE                                                          MA Ø818Ø
                                                                        MA Ø819Ø
  68Ø WRITE (6,934Ø)                                                    MA Ø82ØØ
      WRITE(6,935Ø) (W(K),K=4,8),W(1Ø)                                  MA Ø821Ø
      I=1                                                               MA Ø822Ø
      L=1                                                               MA Ø823Ø
      IV1=V1/5.Ø                                                        MA Ø824Ø
      IV2=V2/5.+.998                                                    MA Ø825Ø
      IV1=5*IV1                                                         MA Ø826Ø
      IV2=5*IV2                                                         MA Ø827Ø
      IF (IV1.LT.35Ø) IV1=35Ø                                           MA Ø828Ø
      IF (IV2.GT.5ØØØØ) IV2=5ØØØØ                                       MA Ø829Ø
      IF (DV.LT.5.) DV=5.                                               MA Ø83ØØ
      IDV=DV                                                            MA Ø831Ø
      IV=IV1-IDV                                                        MA Ø832Ø
      IC=Ø                                                              MA Ø833Ø
      ICOUNT=Ø                                                          MA Ø834Ø
      ICNT=Ø                                                            MA Ø835Ø
      LMAX=LBR                                                          MA Ø836Ø
      LOOP=1                                                            MA Ø837Ø
      IF (IRAD.EQ.1) LOOP=LBR                                           MA Ø838Ø
                                                                        MA Ø839Ø
C****  BEGINING OF TRANSMITTANCE CALCULATIONS                           MA Ø84ØØ
                                                                        MA Ø841Ø
  69Ø IV=IV+IDV                                                         MA Ø842Ø
      ICNT=ICNT+1                                                       MA Ø843Ø
      IF (ICOUNT.EQ.Ø) GO TO 7ØØ                                        MA Ø844Ø
      IF (ICOUNT.EQ.5Ø) GO TO 7ØØ                                       MA Ø845Ø
      GO TO 71Ø                                                         MA Ø846Ø
  7ØØ ICOUNT=Ø                                                          MA Ø847Ø
      WRITE(6,936Ø)                                                     MA Ø848Ø
  71Ø CONTINUE                                                          MA Ø849Ø
                                                                        MA Ø85ØØ
                                                                        MA Ø851Ø
                                                                        MA Ø852Ø
                                                                        MA Ø853Ø
      DO 83Ø LL=1,LOOP                                                  MA Ø854Ø
                                                                        MA Ø855Ø
```

```
      DO 72Ø K=1,1Ø
      TX(K)=Ø.Ø
      IF (K.LT.4) TX(K)=1.Ø
      W(K)=VH(K)
      IF (LL.GT.1) W(K)=W(K)-WW(LL-1,K)
  72Ø CONTINUE

      TX(1)=1.Ø
      ICOUNT=ICOUNT+1
      IC=IC+1
      SUM=Ø.Ø
      V=IV
      I=(IV-35Ø)/5+1
      IF(IV.LT.67Ø) GO TO 8ØØ
      IF(IV.LE.3ØØØ) GO TO 73Ø

C********   MOLECULAR SCATTERING

      C6=9.8Ø7E-2Ø*(V**4.Ø117)
      TX(6)=C6*W(6)
      SUM=SUM+TX(6)
      IF (IV.LT.92ØØ) GO TO 8ØØ
      IF (IV.LT.13ØØØ) GO TO 8ØØ

C********  WATER VAPOR CONTINUUM 1Ø MICRON REGION

  73Ø IF(IV.GT.135Ø) GO TO 74Ø
      TX(5)=(4.18+5578.Ø*DEXP(-7.87E-3*V))*W(5)
      GO TO 78Ø
  74Ø IF(IV.LT.235Ø) GO TO 79Ø

C********  WATER VAPOR CONTINUUM 4 MICRON REGION

      XI=(V-235Ø.Ø)/5Ø.Ø+1.Ø

      DO 75Ø NH=1,15
      XH=XI-FLOAT(NH)
      TX(5)=C5(NH)
      IF(XH) 76Ø,77Ø,75Ø
  75Ø CONTINUE

  76Ø TX(5)=TX(5)+XH*(C5(NH)-C5(NH-1))
  77Ø TX(5)=TX(5)*W(1Ø)
  78Ø SUM=SUM+TX(5)
      IF(IV.LE.135Ø.OR.IV.GT.274Ø) GO TO 8ØØ

C********   NITROGEN CONTINUUM

  79Ø IF (IV.LT.2Ø8Ø) GO TO 8ØØ
      K4=I-346
      TX(4)=C4(K4)*W(4)
      SUM=SUM+TX(4)

C********   AEROSOL EXTINCTION
```

```
800 ALAM=1.ØE+4/V
    XX=Ø.Ø
    YY=Ø.Ø
    IF (IHAZE.EQ.Ø.) GO TO 83Ø

    DO 81Ø N=1,44
    XD=ALAM-VX(N)
    IF(XD)82Ø,81Ø,81Ø
81Ø CONTINUE

82Ø XX=(C7(N)-C7(N-1))*XD/(VX(N)-VX(N-1))+C7(N)
    YY=(C7A(N)-C7A(N-1))*XD/(VX(N)-VX(N-1))+C7A(N)
83Ø TX(1Ø)=YY*W(7)
    TX(7)=XX*W(7)
    SUM=SUM+TX(7)
    TX(9)=SUM

    DO 87Ø K=4,1Ø
    IF (TX(K).EQ.Ø.Ø) GO TO 85Ø
    IF (TX(K).LE.Ø.1) GO TO 84Ø
    IF (TX(K).GT.2Ø.) GO TO 86Ø
    TX(K)=DEXP(-TX(K))
    GO TO 87Ø
84Ø TX(K)=1.Ø-TX(K)+Ø.5*TX(K)*TX(K)
    GO TO 87Ø
85Ø TX(K)=1.Ø
    GO TO 87Ø
86Ø TX(K)=Ø.
87Ø CONTINUE

    TX(1Ø)=1.Ø-TX(1Ø)
    TX(9)=TX(1)*TX(2)*TX(3)*TX(9)
    IF (IV.GE.13ØØØ) TX(3)=TX(8)
    AB=1.-TX(9)
    IF(IV.EQ.IV1.OR.IV.EQ.IV2) AB=Ø.5*AB
    SUMA=SUMA+AB*DV
    IF(LL.EQ.1) WRITE(6,937Ø) IV,ALAM,TX(9),(TX(K),K=1,7),TX(1Ø),SUMA
    IF(IRAD.NE.Ø) TRAN1(IC)=TX(9)
88Ø CONTINUE



C**********ICNT IS INDEXING VARIABLE USED TO FOLD IN CONTINUUM TAU?S

    TAU(ICNT)=TX(9)
    IF (IV.GE.IV2) GO TO 89Ø
    GO TO 69Ø
89Ø WRITE(6,938Ø)
    NUMV=ICNT
    ICNT=1

    DO 92Ø LL=1,LMAX
    FAC=WW(LL,6)
    IF(FAC.NE.Ø.Ø) GO TO 9ØØ
    WH2Ø(LL)=Ø.Ø
```

```
      WO3(LL)=Ø.Ø
      GO TO 91Ø
  9ØØ WH2Ø(LL)=WW(LL,1)/FAC
      WO3(LL)=WW(LL,3)/FAC
  91Ø WGAS(LL)=FAC

C******TEMPORARY PRINT OUT

      IF(TEMP(LL).LT.1ØØ.Ø) TEMP(LL)=1ØØ.Ø
      WRITE(6,939Ø) LL,LYR(LL),ALT(LL),TEMP(LL),PRES(LL),WH2Ø(LL)
     1,WO3(LL),WGAS(LL)
  92Ø CONTINUE

      AB=1.Ø-SUMA/(V2-V1)
      WRITE(6,94ØØ) IV1,IV2,SUMA,AB
C
C*******START OF MIDTRAN CALCULATION  ***********
C
      NPRNT=1
  93Ø   NTAU=Ø
      IF (DVM.LT.Ø.ØØ5) DVM =.ØØ5
      WRITE(6,941Ø) DVM
      KSPEC = 6

C*****READ TAPE BLOCK INTO DISK FILE

C

      REWIND 21
      READ(21,942Ø) VMIN,VMAX,NPT
      IF (V2.GT.VMIN) GO TO 95Ø
  94Ø WRITE(6,9422) V1,V2,VMIN,VMAX
      STOP
  95Ø IF (V1.GE.VMAX) GO TO 94Ø
  96Ø IF (V1.GE.VMIN) GO TO 97Ø
      WRITE(6,9424) V1,VMIN
      V1 = VMIN
  97Ø IF (V2.LE.VMAX) GO TO 98Ø
      WRITE(6,9426) V2,VMAX
      V2 = VMAX
  98Ø CONTINUE

C******READ (P,T) VALUES FROM DISK FILE

      READ(21,9427)(PP(K),K=1,NPT)
      READ(21,9427)(TTT(K),K=1,NPT)

C*****DETERMINE INTERPOLATION POINTS FOR EACH LAYER

      CALL PTPTS(PP,TTT,LMAX,KPTS,TEMP,PRES)
      IF(JP.LT.1) GO TO 985
      WRITE(6,9429) (LL,TEMP(LL),PRES(LL),(KPTS(J,LL),J=1,3),LL=1,LMAX)

C*****READ IN WAVENUMBER BLOCKS
```

```
  985 VCHK1 = V1-1Ø.
      VCHK2 = V2+1Ø.
      ILP = 1
  99Ø NUM1 = 1
      READ (21,942Ø) VA,VB


      DO 1Ø1Ø K=1,KSPEC
      READ(21,943Ø) SPEC(K,1),SPEC(K,2),NUM2
C     WRITE(6,944Ø) SPEC(K,1),SPEC(K,2),NUM2
      NUM(K) = NUM1
      NUM1 =NUM1 + NUM2
      NMIN = NUM(K)
      NMAX = NUM1 - 1

      DO 1ØØØ N=NMIN,NMAX
      READ(21,945Ø) VV(N),(AK(L,N),L=1,NPT)
      IF(VB.LE.VCHK1) GO TO 1ØØØ
      IF(JP.GE.3) WRITE(6,945Ø) VV(N),(AK(L,N),L=1,NPT)
 1ØØØ CONTINUE

 1Ø1Ø CONTINUE


      IF(VA.GT.VCHK1.AND.VB.GE.V1) GO TO 1Ø2Ø
      IF(JP.LT.1) GO TO 99Ø
      WRITE(6,946Ø) VA,(NUM(N),N=1,6),NMAX
      GO TO 99Ø
 1Ø2Ø IF (VA.GE.VCHK2) GO TO 12ØØ
C*****CALCULATE TRANSMISSION

C     WRITE(6,9465) NUM(1),NUM(6)
      ILP =ILP +1
      IF (ILP.GT.6Ø) ILP=1
      V = VV(NMIN) + DVM
      VØ = V
      N = Ø
 1Ø3Ø IF (V.GE.V1) GO TO 1Ø4Ø
      N = N + 1
      V = VØ + FLOAT(N)*DVM
      GO TO 1Ø3Ø
 1Ø4Ø N = Ø
      VØ = V
 1Ø5Ø N = N+1
      RDD = Ø.Ø
      RAD1 = 1.Ø
      FAC1 = Ø.Ø

      DO 1Ø6Ø K=1,KSPEC
      FAC6(K)=Ø.Ø
 1Ø6Ø CONTINUE
```

```
      DO 1140 LL=1,LMAX
      DIST = WGAS(LL)
      CON(1) = WH20(LL)
      CON(3) = WO3(LL)
      FAC2(LL)=0.0
      PBAR = PRES(LL)


      DO 1120 K=1,KSPEC
      NDUM=NUM(K)
      IF (AK(1,NDUM   ).EQ.0.0) GO TO 1120
      M1 = NUM(K)
 1070 VV1 =  VV(M1)
      VV2 =  VV(M1+1)
      IF (V.LE.VV2) GO TO 1090
      M1 = M1+1
      GO TO 1070

 1090 DO 1100 I=1,2
      N1 = M1+I-1
      LDUM=KPTS(1,LL)
      MDUM=KPTS(2,LL)
      NDUM=KPTS(3,LL)
      Y0 = AK(MDUM       ,N1)
      FT = F1(Y0,AK(LDUM       ,N1),TTT(MDUM       ),TTT(LDUM       )
     1   ,TEMP(LL))
      FP = F1(Y0,AK(NDUM       ,N1),PP(MDUM       ),PP(NDUM       )
     1   ,PBAR)
      AKK = FT+FP-Y0
      IF (AKK.LT.0) AKK=0
      IF (VV(N1).EQ.V) GO TO 1110
      FAC5(I) = AKK
 1100 CONTINUE

      AKK = F1(FAC5(1),FAC5(2),VV1,VV2,V)
 1110 FAC=AKK*CON(K)*DIST
      FAC6(K)=FAC6(K)+FAC
      FAC2(LL)=FAC2(LL)+FAC
 1120 CONTINUE


 1140 CONTINUE



      TRAN=1.0

      DO 1150 K=1,KSPEC
      FAC6(K)=FAC6(K)*1.0E5
      HZZ(K)=0.0
      IF(FAC6(K).LT.50.) HZZ(K)=DEXP(-FAC6(K))
      TRAN=TRAN*HZZ(K)
 1150 CONTINUE
```

```
C********** FOLD IN CONTINUUM

 116Ø V3=V1 + DV
      IF (V3.GT.V) GO TO 117Ø
      V1=V1 + DV
      ICNT=ICNT + 1
      IF (V3.GT.V2) STOP
      GO TO 116Ø
 117Ø RDD=F1(TAU(ICNT),TAU(ICNT+1),V1,V3,V)
      TOTAL=TRAN*RDD
      IF(IRAD.EQ.Ø) GO TO 1195
C
C*******RADIATION CALCULATION*****

      AUX=Ø.Ø

      DO 118Ø LL=1,LMAX
      FAC2(LL)=FAC2(LL)*1.ØE5
      AUX=AUX+FAC2(LL)
 118Ø CONTINUE

      JØ=(ICNT-1)*LMAX+1
      J1=JØ+LMAX
      T1=SPF1(TRAN1(JØ),TRAN1(J1),V1,V3,V)
      BUX=Ø.Ø
      IF(-AUX.GT.-673.Ø) BUX=DEXP(-AUX)
      XTAU=T1*BUX
      B1=BLAM(TEMP(1),V)
      XRAD=(EMIS*BLAM(TBACK,V)-B1)*XTAU+BLAM(TEMP(LMAX),V)
      IF(LMAX.EQ.1) GO TO 1195

      DO 119Ø LL=2,LMAX
      JØ=JØ+1
      J1=J1+1
      T1=SPF1(TRAN1(JØ),TRAN1(J1),V1,V3,V)
      AUX=AUX-FAC2(LL-1)
      BUX=Ø.Ø
      IF(-AUX.GT.-673.Ø) BUX=DEXP(-AUX)
      XTAU=T1*BUX
      B2=BLAM(TEMP(LL),V)
      XRAD=XRAD+XTAU*(B1-B2)
      B1=B2
 119Ø CONTINUE

C     ***   SPECIES PRINT OUT   ***

 1195 IF(JP.LT.2) GO TO 1197
      IF(NPRNT.GT.1ØØ) NPRNT=1
      IF(NPRNT.EQ.1) WRITE(6,947Ø) ((SPEC(K,J),J=1,2),K=1,KSPEC)
      IF(NPRNT.LE.11) WRITE(6,948Ø) V,XRAD,TOTAL,RDD,TRAN,HZZ
 1197 NTAU=NTAU+1
      NPRNT=NPRNT+1
      RAD(NTAU)=XRAD
      TAU1(NTAU)=TOTAL
      VTAU(NTAU)=V
```

```
      V = VØ + FLOAT(N)*DVM
      IF (V.GE.V2) GO TO 12ØØ
      IF(NTAU.EQ.4ØØØ) GO TO 12ØØ
      IF (V.LE.VB) GO TO 1Ø5Ø
      N = N - 1
      GO TO 99Ø
C
C***   STORE RESULTS ON OUTPUT FILE 9   ***
C
 12ØØ CONTINUE
      WRITE (9,949Ø) H1,H2
      WRITE (9,95ØØ) NTAU,VTAU(1),VTAU(NTAU),DVM
      WRITE (9,951Ø) (VTAU(J),RAD(J),TAU1(J),J=1,NTAU)
      IF(JP.GE.1) GO TO 12Ø5
      IF(V.GE.V2) GO TO 127Ø
      GO TO 126Ø
C
C     ***   SLIT FUNCTION WITH FIXED WIDTH OF Ø.1 CM-1   ***
C
C
 12Ø5 A=.1
      DELV=A
      DVT=DVM
      V2T=VTAU(NTAU)-A
      FREQT=VTAU(1)+A
      VT=VTAU(1)
      JFNU=1
      L=DELV/DVT+Ø.Ø1
      IA=1
 121Ø SUM=Ø.Ø
      RSUM=Ø.Ø

      DO 122Ø I=IA,NTAU
      VT=VTAU(I)
      AA=A-DABS(VT-FREQT)
      SUM=SUM+AA*TAU1(I)
      RSUM=RSUM+AA*RAD(I)
      IF(VT-(FREQT+A)) 122Ø,123Ø,123Ø
 122Ø CONTINUE

 123Ø TRANS(JFNU)=SUM*DVT/(A*A)
      FRAD(JFNU)=RSUM*DVT/(A*A)
      FNU(JFNU)=FREQT
      IF(FREQT.GT.V2T) GO TO 124Ø
      FREQT=FREQT+DELV
      IF(JFNU.GE.5ØØ) GO TO 124Ø
      JFNU=JFNU+1
      IA=IA+L
      GO TO 121Ø
 124Ø WRITE(6,952Ø) JFNU
      WRITE(6,953Ø)
      JFAC=JFNU/4
      J1=JFAC
      J2=2*JFAC
      J3=3*JFAC
```

```
      DO 1245 J=1,JFAC
      J1DUM=J1+J
      J2DUM=J2+J
      J3DUM=J3+J
      WRITE(6,9540)  FNU(J),FRAD(J),TRANS(J),FNU(J1DUM),FRAD(J1DUM),
     X TRANS(J1DUM),FNU(J2DUM),FRAD(J2DUM),TRANS(J2DUM),FNU(J3DUM),
     X FRAD(J3DUM),TRANS(J3DUM)
 1245 CONTINUE

      J2=JFAC*4
      JDELT=JFNU-J2
      IF(JDELT.GT.0) WRITE(6,9550) (FNU(J),FRAD(J),TRANS(J),J=J2,JFNU)
      IF(FREQT.GE.V2-DVM-A) GO TO 1270
      IF(FREQT.GE.V2T) GO TO 1260
      IF(JFNU.GE.500) GO TO 1250
      GO TO 1260
 1250 JFNU=1
      GO TO 1210
 1260 NTAU=0
      IF(V.LT.VB) GO TO 1050
      N=N-1
      GO TO 990
 1270 WRITE(9,9490) ENDF
      NFILES=NFILES+1

      GO TO 20

 9010 FORMAT(10I3,F10.3)
 9020 FORMAT(8E10.3)
 9030 FORMAT(F6.1,2(E10.3,F6.1,2E10.3))
 9040 FORMAT(4(F6.2,2F7.5))
 9050 FORMAT(4(F6.3,2F7.4))
 9060 FORMAT(15F5.2)
 9070 FORMAT(8E9.2)
 9075 FORMAT(I10,2F10.3,4I5,2F10.3)
 9080 FORMAT(7F10.3)
 9085 FORMAT(12H EMISSIVITY=,F5.3,10X,14HT(BACKGROUND)=,F10.1,9HDEGREES
     XK)
 9090 FORMAT(10X,7F10.3)
 9100 FORMAT(10X,4H H1=,F7.3,6HKM,H2=,F7.3,9HKM,ANGLE=,F8.4,13HGEOM. RAN
     XGE =,F7.2,8HKM,BETA=,F8.5,5H,VIS=,F6.1)
 9110 FORMAT(3F10.3,2F5.1,2E10.3,2F10.3)
 9115 FORMAT(10X,26HINPUT METEOROLOGICAL DATA:/10X,2HZ=,F7.2,7H KM, P=,
     XF7.2,6H MB,T=,F5.1,15H C, DEW PT.TEMP,F5.1,17H REL HUMIDITY=,
     XF5.1,16H %, H2O DENSITY=,1PE9.2,7H GM M-3/10X,15H OZONE DENSITY=,
     XE9.2,20H GM-3, VISUAL RANGE=,0PF6.1,10H KM,RANGE=,F10.3,4H KM )
 9120 FORMAT(25H  MODEL ATMOSPHERE NO. 7,/4X,6HZ (KM),3X,6HP (MB),4X,
     X49HT (C) DEW PT %RH  H2O(GM.M-3) O3(GM.M-3) NO. DEN.)
 9130 FORMAT(//10X,28H HORIZONTAL PATH, ALTITUDE =,F7.3,11H KM,RANGE =,
     XF7.3,3H KM)
 9140 FORMAT(//10X,51H SLANT PATH BETWEEN ALTITUDES H1 AND H2 WHERE H1
     X=,F7.3,8H KM H2 =,F7.3,18H KM,ZENITH ANGLE =,F7.3,8H DEGREES)
 9150 FORMAT(//10X,39H SLANT PATH TO SPACE FROM ALTITUDE H1 =,F7.3,20H
     XKM, ZENITH ANGLE =,F7.3,8H DEGREES)
 9160 FORMAT(/25X,13HHAZE MODEL  =,F5.1,29H KM VISUAL RANGE AT SEA LEVEL
     X)
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9165 FORMAT(61H  FOG CONDITIONS MAY EXIST AT LEA LEVEL FOR THIS VISUAL MA 1297Ø
    XRANGE,/,94H  IF SO THEN ASSUME THE TRANSMITTANCE DUE TO FOG IS GIVMA 1298Ø
    XEN BY THE TRANSMITTANCE AT Ø.55 MICRONS)                          MA 1299Ø
917Ø FORMAT(/2ØX,18H MODEL ATMOSPHERE ,I1,11H = TROPICAL)              MA 13ØØØ
918Ø FORMAT(/2ØX,18H MODEL ATMOSPHERE ,I1,21H = MIDLATITUDE SUMMER)    MA 13Ø1Ø
919Ø FORMAT(/2ØX,18H MODEL ATMOSPHERE ,I1,21H = MIDLATITUDE WINTER)    MA 13Ø2Ø
92ØØ FORMAT(/2ØX,18H MODEL ATMOSPHERE ,I1,21H = SUB-ARCTIC SUMMER )    MA 13Ø3Ø
921Ø FORMAT(/2ØX,18H MODEL ATMOSPHERE ,I1,21H = SUB-ARCTIC WINTER )    MA 13Ø4Ø
922Ø FORMAT(/2ØX,18H MODEL ATMOSPHERE ,I1,21H = 1962 US STANDARD  )    MA 13Ø5Ø
923Ø FORMAT(/2ØX,39HAEROSOL SCATTERING NOT COMPUTED,IHAZE=Ø)           MA 13Ø6Ø
9235 FORMAT(/2ØX,18H        HAZE MODEL ,I1,3H = ,2A2,13H VISUAL RANGE)  MA 13Ø7Ø
924Ø FORMAT(/1ØX,21H FREQUENCY RANGE V1= ,F7.1,13H CM-1 TO V2= ,F7.1,  MA 13Ø8Ø
    X14H CM-1 FOR DV =,F6.1,9H CM-1    (,F6.2,3H - ,F5.2,1ØH MICRONS )) MA 13Ø9Ø
925Ø FORMAT(1H1,///1ØX,2ØH HORIZONTAL PROFILES/)                       MA 131ØØ
926Ø FORMAT(69H TRAJECTORY MISSES EARTHS ATMOSPHERE. CLOSEST DISTANCE OMA 1311Ø
    XF APPROACH IS,F1Ø.2,1X,/,1X,18HEND OF CALCULATION)                MA 1312Ø
927Ø FORMAT(1ØX,I4,F6.1,11(E1Ø.3))                                     MA 1313Ø
928Ø FORMAT(1H1,///1ØX,21H  VERTICAL PROFILES   ,64X,3HPSI,6X,3HPHI,6X, MA 1314Ø
    X4HBETA,4X,14HTHETA     RANGE)                                     MA 1315Ø
929Ø FORMAT(I5,F7.1,8E1Ø.3,4F9.4,F7.1)                                 MA 1316Ø
93ØØ FORMAT(8H HMIN = ,F1Ø.3)                                          MA 1317Ø
93Ø5 FORMAT(75H H2 WAS SET LESS THAN HMIN AND HAS BEEN RESET EQUAL TO  MA 1318Ø
    X    HMIN I.E. H2 = ,F1Ø.3)                                        MA 1319Ø
931Ø FORMAT(65H PATH INTERSECTS EARTH - PATH CHANGED TO TYPE 2 WITH H2 MA 132ØØ
    X=  Ø.Ø KM)                                                        MA 1321Ø
932Ø FORMAT(85H CHOICE OF TWO PATHS FOR THIS CASE -SHORTEST PATH TAKEN.MA 1322Ø
    X   FOR LONGER PATH SET LEN=1.)                                    MA 1323Ø
933Ø FORMAT(85H CHOICE OF TWO PATHS FOR THIS CASE -LONGEST PATH TAKEN. MA 1324Ø
    X   FOR SHORT PATH SET LEN = Ø )                                   MA 1325Ø
934Ø FORMAT(/11X,37HEQUIVALENT SEA LEVEL ABSORBER AMOUNTS//21X,11ØHWATEMA 1326Ø
    XR VAPOUR     CO2 ETC.      OZONE    NITROGEN (CONT)  H2O (CONT)  MA 1327Ø
    X   MOL  SCAT      AEROSOL     OZONE(U-V)/24X,7X       ,1ØX,2X  ,1ØMA 1328Ø
    XX,6X       ,1ØX,2HKM,9X,7HGM CM-2,1ØX,2HKM,13X,2HKM,1ØX,6HATM CM)  MA 1329Ø
935Ø FORMAT(/1ØX,8H W(1-8)=42X,5(E14.3)/ 74X,E14.3/)                   MA 133ØØ
936Ø FORMAT(1H1,/1ØX,32H FREQ WAVELENGTH  TOTAL      H2O,5X4HCO2+,5X,64HMA 1331Ø
    XOZONE  N2 CONT  H2O CONT MOL SCAT  AEROSOL  AEROSOL   INTEGRATED /MA 1332Ø
    X11X,14H CM-1  MICRONS,8(4X5HTRANS),4X,2ØH ABS      ABSORPTION )   MA 1333Ø
937Ø FORMAT(1ØX,I6,1ØF9.4,F12.2)                                       MA 1334Ø
938Ø FORMAT(///1X,2HLL,3X,5HLEVEL,2X,8HALTITUDE,3X,4HTEMP,6X,4HPRES,7X,MA 1335Ø
    X4HWH2O,7X,3HWO3,8X,4HWGAS/)                                       MA 1336Ø
939Ø FORMAT(I3,I6,3F1Ø.2,2X,3E11.3)                                    MA 1337Ø
94ØØ FORMAT(26H INTEGRATED ASORPTION FROM,I5,3H TO,I5,7H CM-1 =,F1Ø.2, MA 1338Ø
    X24H,AVERAGE TRANSMITTANCE =,F6.4)                                 MA 1339Ø
941Ø FORMAT(/26H MEDIUM  RESOLUTION   DVM=,F5.3,12H WAVENUMBERS/)      MA 134ØØ
942Ø FORMAT(2F1Ø.2,I5)                                                 MA 1341Ø
9422 FORMAT(26H TAPE OUT OF RANGE OF DATA/5H V1 =,F7.1,6H, V2 =,F7.1,  MA 1342Ø
    X8H, VMIN =,F7.1,8H, VMAX =,F7.1)                                  MA 1343Ø
9424 FORMAT(//5H V1 =,F1Ø.2,5X,19HTOO SMALL, RESET TO,F1Ø.2,4HCM-1)    MA 1344Ø
9426 FORMAT(//5H V2 =,F1Ø.2,5X,18HTOO LARGE,RESET TO,F1Ø.2,4HCM-1)     MA 1345Ø
9427 FORMAT(9F1Ø.2)                                                    MA 1346Ø
9429 FORMAT(41H INTERPOLATION POINTS RETURNED FROM PTPTS/              MA 1347Ø
    X66(I5,2F1Ø.3,3I6/))                                               MA 1348Ø
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9430 FORMAT(2A2,I5)                                                       MA 13490
9440 FORMAT(1X,2A2,I10,21H CALCULATIONAL POINTS)                          MA 13500
9450 FORMAT(F12.2,9E12.6)                                                 MA 13510
9460 FORMAT(19H BLOCK SKIPPED, V =,F10.2,12H WAVENUMBERS,7I6)             MA 13520
9465 FORMAT(13H NMIN,NMAX = ,2I10)                                        MA 13530
9470 FORMAT(1X,3X,5HFREQ.,5X,4HRAD.,3X,13HTRANSMITTANCE,3X,5HCONT.,6X,    MA 13540
    X6HH1 RES,6(8X,2A2))                                                  MA 13550
9480 FORMAT(F9.2,E10.3,F11.4,3F12.4)                                      MA 13560
9490 FORMAT(2F10.2)                                                       MA 13570
9500 FORMAT(I10,3F10.4)                                                   MA 13580
9510 FORMAT(F12.4,2E12.4)                                                 MA 13590
9520 FORMAT(7H JFNU =,I5)                                                 MA 13600
9530 FORMAT(4(3X,7H FREQ. ,2X,10H   RAD.    ,2X,8H TRANS. ))              MA 13610
9540 FORMAT(4(3X,F7.2,2X,E10.3,2X,F8.6))                                  MA 13620
9550 FORMAT(96X,3X,F7.2,2X,E10.3,2X,F8.6)                                 MA 13630
     END                                                                  MA 13640
```

```
      SUBROUTINE POINT (X,YN,N,NP,TX,IP)
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      COMMON Z(34),P(7,34),T(7,34),EH(1Ø,34),WH(7,34),M,NL,RE,CW,CO,PI
      DIMENSION TX(12)
C***********************************************************************
C     SUBROUTINE POINT COMPUTES THE MEAN REFRATIVE INDEX ABOVE AND BELOW
C     A GIVEN ALTITUDE AND INTERPOLATES EXPONENTIALLY TO DETERMINE THE
C     EQUIVALENT ABSORBER AMOUNTS AT THAT ALTITUDE.
C
C***********************************************************************
C
C      X IS THE HEIGHT IN QUESTION
C      TX(9) AND YN ARE THE MEAN REFRACTIVE INDICES ABOVE AND BELOW X
C      N IS THE LEVEL INTEGER CORRESPONDING TO X OR THE LEVEL BELOW X
C      NP =1 IF X COINCIDES WITH MODEL ATMOSPHERE LEVEL ,IF NOT NP = Ø
C      TX(1-8) ARE ABSORBER  AMOUNTS PER KM AT HEIGHT X
C***********************************************************************
      N=NL
      NP=Ø
      IF (X.LT.Ø.Ø) X=Ø.
      IF (X.GT.Z(NL)) GO TO 4
      DO 1 I=1,NL
      N=I
      IF (X-Z(I)) 2,4,1
1     CONTINUE
2     J2=N
      N=N-1
      FAC=(X-Z(N))/(Z(J2)-Z(N))
      PX1=P(M,N)*(P(M,J2)/P(M,N))**FAC
      TX1=T(M,N)*(T(M,J2)/T(M,N))**FAC
      TX(11)=TX1
      TX(12)=PX1
      WX1=WH(M,N)*(WH(M,J2)/WH(M,N))**FAC
      TX(3)=CO*PX1/TX1-4.56E-6*WX1*TX1*CW
      TX(2)=CO*P(M,J2)/T(M,J2)-4.56E-6*WH(M,J2)*T(M,J2)*CW
      TX(1)=CO*P(M,N)/T(M,N)-4.56E-6*WH(M,N)*T(M,N)*CW
      TX(9)=Ø.5E-6*(TX(2)+TX(3))
      YN=Ø.5E-6*(TX(1)+TX(3))
      IF (IP.EQ.Ø) GO TO 9
      DO 3 L=1,9
      K=L
      IF(L.EQ.9) K=1Ø
      IF (EH(K,N).EQ.Ø.Ø) GO TO 3
      IF (EH(K,N).GT.1ØØØ.Ø) GO TO 3
      TX(K)=EH(K,N)*(EH(K,J2)/EH(K,N))**FAC
3     CONTINUE
      GO TO 9
4     NP=1
      IF (IP.EQ.Ø) GO TO 6
      DO 5 K=1,1Ø
5     TX(K)=EH(K,N)
      TX(11)=T(M,N)
      TX(12)=P(M,N)
6     TX(9)=EH(9,N)-1.
```

```
      YN=Ø.Ø                                                             PO ØØ5ØØ
      IF (N.GT.1) YN=EH(9,N-1)-1.Ø                                       PO ØØ51Ø
9     CONTINUE                                                           PO ØØ52Ø
      IF (IP.EQ.1) WRITE(6,4ØØ) X,N,NP,TX(9),YN,IP,(TX(K),K=1,8)         PO ØØ53Ø
      TX(9)=TX(9)+1.                                                     PO ØØ54Ø
      YN=YN+1.                                                           PO ØØ55Ø
      RETURN                                                             PO ØØ56Ø
C                                                                        PO ØØ57Ø
4ØØ   FORMAT(/,2ØH FROM POINT: HEIGHT=,F1Ø.4,6H KM,N=,I3,4H,NP=,I2,      PO ØØ58Ø
     X29H,REF . INDEX ABOVE & BELOW X=,2E11.4,4H,IP=,I3,/,12X,37HEQUIV.  PO ØØ59Ø
     XABSORBER  AMOUNTS PER KM AT X=,8E1Ø.3)                             PO ØØ6ØØ
      END                                                                PO ØØ61Ø
      SUBROUTINE PTPTS (PP,TT,IMAX,KPTS,TEMP,PRES)                       PT ØØØ1Ø
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)                                PT ØØØ2Ø
      DIMENSION PP(9),TT(9),KPTS(3,4Ø),TEMP(1),PRES(1)                   PT ØØØ3Ø
C**********SUBROUTINE WRITTEN FOR 9 P,T POINTS                           PT ØØØ4Ø
      DO 6Ø J=1,IMAX                                                     PT ØØØ5Ø
      PØ=PRES(J)                                                         PT ØØØ6Ø
      TØ=TEMP(J)                                                         PT ØØØ7Ø
C*****IF (ICALC2.GT.Ø) GO TO 5Ø                                          PT ØØØ8Ø
C*****ICALC2=1                                                           PT ØØØ9Ø
C**********FIRST CALL AT GIVEN P,T---LOCATE INTERPOLATION POINTS         PT ØØ1ØØ
      IF (PØ.GT.PP(5).AND.TØ.GT.TT(5)) GO TO 15                          PT ØØ11Ø
      IF (PØ.GT.PP(3)) GO TO 5                                           PT ØØ12Ø
      K1=1                                                               PT ØØ13Ø
      K2=2                                                               PT ØØ14Ø
      K3=3                                                               PT ØØ15Ø
      IF (TØ.LE.TT(2)) GO TO 5Ø                                          PT ØØ16Ø
      K1=4                                                               PT ØØ17Ø
      K2=3                                                               PT ØØ18Ø
      K3=2                                                               PT ØØ19Ø
      GO TO 5Ø                                                           PT ØØ2ØØ
5     IF (PØ.GT.PP(5)) GO TO 1Ø                                          PT ØØ21Ø
      K1=3                                                               PT ØØ22Ø
      K2=4                                                               PT ØØ23Ø
      K3=5                                                               PT ØØ24Ø
      IF (TØ.LE.TT(5)) GO TO 5Ø                                          PT ØØ25Ø
      K1=6                                                               PT ØØ26Ø
      K2=5                                                               PT ØØ27Ø
      K3=4                                                               PT ØØ28Ø
      GO TO 5Ø                                                           PT ØØ29Ø
1Ø    K1=6                                                               PT ØØ3ØØ
      K2=5                                                               PT ØØ31Ø
      K3=7                                                               PT ØØ32Ø
      PMID=Ø.5*(PP(5)+PP(7))                                             PT ØØ33Ø
      IF (PØ.LT.PMID) GO TO 5Ø                                           PT ØØ34Ø
      K1=8                                                               PT ØØ35Ø
      K2=7                                                               PT ØØ36Ø
      K3=5                                                               PT ØØ37Ø
      GO TO 5Ø                                                           PT ØØ38Ø
```

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15    IF (PØ.GT.PP(7)) GO TO 25                                  PT ØØ39Ø
      K1=9                                                       PT ØØ4ØØ
      K2=8                                                       PT ØØ41Ø
      K3=6                                                       PT ØØ42Ø
      IF (TØ.GT.TT(6)) GO TO 5Ø                                  PT ØØ43Ø
      A6=(TØ - TT(6))**2 + (PØ - PP(6))**2                       PT ØØ44Ø
      A7=(TØ - TT(7))**2 + (PØ - PP(7))**2                       PT ØØ45Ø
      IF (A6.GT.A7) GO TO 2Ø                                     PT ØØ46Ø
      K1=5                                                       PT ØØ47Ø
      K2=6                                                       PT ØØ48Ø
      K3=8                                                       PT ØØ49Ø
      GO TO 5Ø                                                   PT ØØ5ØØ
2Ø    IF (TØ.GT.TT(8)) GO TO 3Ø                                  PT ØØ51Ø
      K1=8                                                       PT ØØ52Ø
      K2=7                                                       PT ØØ53Ø
      K3=5                                                       PT ØØ54Ø
      GO TO 5Ø                                                   PT ØØ55Ø
25    TMID=Ø.5*(TT(7) + TT(8))                                   PT ØØ56Ø
      K1=8                                                       PT ØØ57Ø
      K2=7                                                       PT ØØ58Ø
      K3=5                                                       PT ØØ59Ø
      IF (TØ.LE.TMID) GO TO 5Ø                                   PT ØØ6ØØ
      K1=7                                                       PT ØØ61Ø
      K2=8                                                       PT ØØ62Ø
      K3=6                                                       PT ØØ63Ø
      GO TO 5Ø                                                   PT ØØ64Ø
3Ø    K1=9                                                       PT ØØ65Ø
      K2=8                                                       PT ØØ66Ø
      K3=6                                                       PT ØØ67Ø
5Ø    CONTINUE                                                   PT ØØ68Ø
      KPTS(1,J)=K1                                               PT ØØ69Ø
      KPTS(2,J)=K2                                               PT ØØ7ØØ
      KPTS(3,J)=K3                                               PT ØØ71Ø
6Ø    CONTINUE                                                   PT ØØ72Ø
      RETURN                                                     PT ØØ73Ø
      END                                                        PT ØØ74Ø
```

```
      SUBROUTINE ANGL (H1,H2,ANGLE,B1,LEN,ML)
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      COMMON Z(34),P(7,34),T(7,34),EH(1Ø,34),WH(7,34),M,ML,RE,CW,CO,PI
      DIMENSION TX(1Ø)
C***********************************************************************
C
C     THIS SUBROUTINE CALCULATES THE INITIAL ZENITH ANGLE (ANGLE)
C     TAKING INTO ACCOUNT REFRACTION EFFECTS GIVEN H1,H2, AND BETA
C     (WHERE BETA IS THE EARTH CENTRE ANGLE SUBTENDED BY H1 AND H2 ),
C     ASSUMING THE REFRACTIVE INDEX TO BE CONSTANT IN A GIVEN LAYER.
C     FOR GREATER ACCURACY INCREASE THE NUMBER OF LEVELS IN THE MODEL
C     ATMOSPHERE.
C
C     THIS SUBROUTINE CAN BE REMOVED FROM THE PROGRAM IF NOT REQUIRED.
C***********************************************************************
      IP=99
      CA=PI/18Ø.
      X1=RE+H1
      X2=RE+H2
      LEN=Ø.
      IT=Ø
      B1=B1*CA
      IF(B1.EQ.Ø.Ø) B1=DACOS(X2/X1)
      TANG=X2*DSIN(B1)/(X2*DCOS(B1)-X1)
      THET=DATAN(TANG)
      IF (THET.LT.Ø.Ø) THET=THET+PI
      SPHI=DSIN(THET)
      ANG=THET/CA
C     WRITE(6,4Ø4) B1,ANG,TANG
      TN=THET
      TM=TN-Ø.5*CA
1     ANGLE=THET
      FBT=Ø.
      BETA=Ø.
      BET1=Ø
      BET2=Ø
      FBT1=Ø
      FBT2=Ø
      FBT3=Ø.Ø
      IF(B1.LE.Ø.Ø) GO TO 2
C     WRITE(6,4ØØ) IT
      Y=2.*THET
      IF (Y-PI.GT.1.ØE-8) GO TO 9
      IF (IP.EQ.1ØØ) GO TO 6
      XMIN=X2*DCOS(B1)-RE
      IF (XMIN-H1) 8,4,4
    2 HMIN=H2
      H2=H1
      H1=HMIN
3     ANGLE=Ø.5*PI
      THET=ANGLE
      SPHI=1.Ø
      ANG=ANGLE/CA
C     WRITE(6,4Ø4) B1,ANG,SPHI
4     IP=1ØØ
      CALL POINT (H1,YM,M,MP,TX,IP)
```

```
      J1=N                                                    AN ØØ57Ø
      TX1=TX(9)                                               AN ØØ58Ø
5     CALL POINT (H2,YN,N,NP,TX,IP)                           AN ØØ59Ø
      IF (NP.EQ.1) N=N-1                                      AN ØØ6ØØ
      J2=N                                                    AN ØØ61Ø
      IF (J1.EQ.J2) TX1=TX1+YN-EH(9,J1)                       AN ØØ62Ø
6     DO 7 J=J1,J2                                            AN ØØ63Ø
      X1=RE+Z(J)                                              AN ØØ64Ø
      X2=RE+Z(J+1)                                            AN ØØ65Ø
      IF (J.EQ.J1) X1=RE+H1                                   AN ØØ66Ø
      IF (J.EQ.J2) X2=RE+H2                                   AN ØØ67Ø
      SALP=X1*SPHI/X2                                         AN ØØ68Ø
      ALP=DASIN(SALP)                                         AN ØØ69Ø
      RN=EH(9,J+1)/EH(9,J)                                    AN ØØ7ØØ
      IF ((J+1).EQ.J2) RN=YN/EH(9,J)                          AN ØØ71Ø
      IF (J.EQ.J1) RN=EH(9,J+1)/TX1                           AN ØØ72Ø
      IF ((J+1).EQ.J2.AND.J.EQ.J1) RN=YN/TX1                  AN ØØ73Ø
      BET=THET-ALP                                            AN ØØ74Ø
      FB=-DTAN(ALP)                                           AN ØØ75Ø
      IF (J.NE.J1) FB=FB+DTAN(THET)                           AN ØØ76Ø
      FBT=FBT+FB                                              AN ØØ77Ø
      BETA=BETA+BET                                           AN ØØ78Ø
      TH1=THET/CA                                             AN ØØ79Ø
      BE=BET/CA                                               AN ØØ8ØØ
      C=ALP/CA                                                AN ØØ81Ø
C     WRITE(6,4Ø2) J,Z(J),THET,ALP,BET,BETA,FBT,FB,TH1,BE,C   AN ØØ82Ø
      IF (X2.EQ.RE+H2) C=PI-ALP                               AN ØØ83Ø
      IF (SALP.GE.RN) RN=1.                                   AN ØØ84Ø
      SPHI=SALP/RN                                            AN ØØ85Ø
      THET=DASIN(SPHI)                                        AN ØØ86Ø
7     CONTINUE                                                AN ØØ87Ø
      IF(B1.LE.Ø.Ø) GO TO 29                                  AN ØØ88Ø
      GO TO 26                                                AN ØØ89Ø
8     CONTINUE                                                AN ØØ9ØØ
      TANG=-TANG                                              AN ØØ91Ø
      ANGLE=PI-ANGLE                                          AN ØØ92Ø
      TN=ANGLE                                                AN ØØ93Ø
      ANG=ANGLE/CA                                            AN ØØ94Ø
C     WRITE(6,4Ø4) B1,ANG,TANG                                AN ØØ95Ø
      IF (H1.LE.Ø.Ø) GO TO 3                                  AN ØØ96Ø
9     CONTINUE                                                AN ØØ97Ø
      IP=1Ø1                                                  AN ØØ98Ø
      CALL POINT (H1,YN,N,NP1,TX,IP)                          AN ØØ99Ø
      TX1=TX(9)                                               AN Ø1ØØØ
      YN1=YN                                                  AN Ø1Ø1Ø
      IF (NP1.EQ.1) N=N-1                                     AN Ø1Ø2Ø
      J2=NL                                                   AN Ø1Ø3Ø
      IF (M.EQ.7) J2=ML                                       AN Ø1Ø4Ø
      J1=N                                                    AN Ø1Ø5Ø
      J=J1+1                                                  AN Ø1Ø6Ø
      IF (H2.GE.H1) GO TO 13                                  AN Ø1Ø7Ø
      CALL POINT (H2,YN,N,NP,TX,IP)                           AN Ø1Ø8Ø
      TX2=TX(9)                                               AN Ø1Ø9Ø
      YN2=YN                                                  AN Ø11ØØ
      J2=N                                                    AN Ø111Ø
      IF (J1.EQ.J2) TX2=YN1+TX(9)-EH(9,J1)                    AN Ø112Ø
```

```
1Ø    J=J-1
      X1=RE+Z(J+1)
      X2=RE+Z(J)
      IF (J.EQ.J1) X1=RE+H1
      IF (J.EQ.J2) X2=RE+H2
      SALP=X1*SPHI/X2
      HMIN=X1*SPHI-RE
C     WRITE(6,4Ø2) J,X1,Z(J),SPHI,SALP,HMIN,RE
      IF (SALP.LE.1.Ø) GO TO 11
      SALP=SPHI
      IF (HMIN.GT.H2) GO TO 18
11    ALP=DASIN(SALP)
      THET=DASIN(SPHI)
      BET=ALP-THET
      BET1=BET1+BET
      FB=DTAN(ALP)
      IF (J.NE.J1) FB=FB-DTAN(THET)
      FBT1=FBT1+FB
      TH1=THET/CA
      EE=BET/CA
      AL=ALP/CA
C     WRITE(6,4Ø2) J,X2,THET,ALP,BET1,BET,BMIN,HMIN,FBT1,TH1,BE,AL
      IF (X2.EQ.RE+H2) C=PI-ALP
      REF=EH(9,J)
      IF (J.EQ.J1) REF=YN1
      IF (J.EQ.J2) REF=TX2
      IF (J.EQ.1) CO TO 12
      RN=EH(9,J)/EH(9,J-1)
      IF (J.EQ.J1) RN=YN1/EH(9,J-1)
      IF(J.EQ.J2+1) RN=REF/TX2
      IF(J.EQ.J2) RN=REF/YN2
      IF (SALP.GE.RN) RN=1.
      SPHI=SALP*RN
      IF (Z(J).LE.H2) GO TO 12
      GO TO 1Ø
12    X1=X2
      IF (DABS(Z(J)-H2).LT.1.ØE-1Ø.AND.J.NE.1) GO TO 13
      GO TO 14
13    J=J-1
      X1=RE+Z(J+1)
      IF (J.EQ.J1) X1=RE+H1
      IF (J.EQ.J2.AND.J.NE.J1) X1=RE+H2
14    X2=RE+Z(J)
      HMIN=X1*SPHI-RE
      IF (HMIN.LE.Ø.Ø) GO TO 25
      IF (Z(J).LT.HMIN) GO TO 18
      REF=EH(9,J)
      IF (J.EQ.J2) REF=YN
      SALP=X1*SPHI/X2
      ALP=DASIN(SALP)
      THET=DASIN(SPHI)
      BET=ALP-THET
      FB=DTAN(ALP)-DTAN(THET)
      FBT2=FBT2+FB
      BET2=BET2+BET
      BMIN=BET1+BET2
```

```
      AL=ALP/CA                                                         AN Ø169Ø
      TH1=THET/CA                                                       AN Ø17ØØ
C     WRITE(6,4Ø2) J,X2,THET,ALP,BET2,BET,BMIN,HMIN,FBT2,TH1,BE,AL      AN Ø171Ø
      RN=REF/EH(9,J-1)                                                  AN Ø172Ø
      IF (SALP.GE.RN) RN=1.Ø                                            AN Ø173Ø
      SPHI=SALP*RN                                                      AN Ø174Ø
      GO TO 13                                                          AN Ø175Ø
17    TX3=YN1+TX(9)-EH(9,J1)                                            AN Ø176Ø
      YN1=TX3                                                           AN Ø177Ø
      IF (DABS(H2-Z(J+1)).LE.1.ØE-5) YN1=TX(9)                          AN Ø178Ø
      IF (DABS(H1-Z(J+1)).LE.1.ØE-5) YN1=TX(9)                          AN Ø179Ø
      RN=1.Ø                                                            AN Ø18ØØ
      GO TO 19                                                          AN Ø181Ø
18    CALL POINT (HMIN,YN,N,NP,TX,IP)                                   AN Ø182Ø
      IP=1Ø2                                                            AN Ø183Ø
      TX3=TX(9)                                                         AN Ø184Ø
      IF (J.EQ.J1.AND.H2.GE.H1) GO TO 17                                AN Ø185Ø
      IF (J.EQ.J1.OR.J.EQ.J2) TX3=YN2+TX(9)-EH(9,J)                     AN Ø186Ø
      IF (HMIN.GT.H2) TX3=TX(9)                                         AN Ø187Ø
      IF (J.EQ.J1.AND.HMIN.GT.H2) GO TO 17                              AN Ø188Ø
      RN=REF/TX3                                                        AN Ø189Ø
      IF (SALP.GE.RN) RN=1.                                             AN Ø19ØØ
      SPHI=SALP*RN                                                      AN Ø191Ø
      X=X1*SPHI-RE                                                      AN Ø192Ø
      DIF=DABS(HMIN-X)                                                  AN Ø193Ø
      HMIN=X                                                            AN Ø194Ø
      IF (DIF-1.ØE-5) 19,19,18                                          AN Ø195Ø
19    X2=RE+HMIN                                                        AN Ø196Ø
C     WRITE(6,4Ø3) HMIN,DIF,RN                                          AN Ø197Ø
      THET=DASIN(SPHI)                                                  AN Ø198Ø
      IF(RN.EQ.1.Ø) FBT3=-DTAN(THET)                                    AN Ø199Ø
      IF (RN.EQ.1) GO TO 2Ø                                             AN Ø2ØØØ
      DNX=(TX3-1.Ø)*DLOG((TX3-1.Ø)/(REF-1.Ø))/(X2-X1)                   AN Ø2Ø1Ø
      FBT3=-DTAN(THET)*(1.Ø-1.Ø/(1.Ø+TX3/(X2*DNX)))                     AN Ø2Ø2Ø
2Ø    BET=Ø.5*PI-THET                                                   AN Ø2Ø3Ø
                                                                        AN Ø2Ø4Ø
      BET2=BET2+BET                                                     AN Ø2Ø5Ø
      BMIN=BET1+BET2                                                    AN Ø2Ø6Ø
      IF (H2.GE.H1) GO TO 23                                            AN Ø2Ø7Ø
      BET=BET1+2.*BET2                                                  AN Ø2Ø8Ø
      DB1=B1-BET1                                                       AN Ø2Ø9Ø
      DB2=BET-B1                                                        AN Ø21ØØ
  21    DB3=DABS(BMIN-B1)                                               AN Ø211Ø
      IF(DB3.GT.DB1.AND.DB2.GT.DB1) GO TO 25                            AN Ø212Ø
      IF(DB2.GT.DB3) GO TO 22                                           AN Ø213Ø
      IF(DB2.GT.DB1)  GO TO 25                                          AN Ø214Ø
      BETA=BET                                                          AN Ø215Ø
      FBT=FBT1+2.Ø*(FBT2+FBT3)                                          AN Ø216Ø
      LEN=1.                                                            AN Ø217Ø
      GO TO 26                                                          AN Ø218Ø
22    BETA=BET1+BET2                                                    AN Ø219Ø
      FBT=FBT1+FBT2+FBT3                                                AN Ø22ØØ
C     WRITE(6,4Ø1) J,BETA,FBT,FBT1,FBT2,FBT3,TX1,YN1                    AN Ø221Ø
      GO TO 26                                                          AN Ø222Ø
23    BETA=2.Ø*(BET1+BET2)                                              AN Ø223Ø
      LEN=1.                                                            AN Ø224Ø
```

```
      FBT=2.0*(FBT1+FBT2+FBT3)                                          AN 02250
      WRITE(6,401) J,BETA,FBT,FBT1,FBT2,FBT3,TX1,YN1                    AN 02260
      IF (H2.EQ.H1) GO TO 26                                            AN 02270
      IP=103                                                            AN 02280
      IF (NP1.EQ.1) J1=J1+1                                             AN 02290
      SPHI=DSIN(ANGLE)                                                  AN 02300
      IF (Z(J1+1).LE.H2) GO TO 24                                       AN 02310
      RN=TX1/YN1                                                        AN 02320
      IF (SPHI.GE.RN) RN=1.                                             AN 02330
      SPHI=SPHI/RN                                                      AN 02340
      THET=DASIN(SPHI)                                                  AN 02350
      GO TO 5                                                           AN 02360
24    CALL POINT (H2,YN,N,NP,TX,IP)                                     AN 02370
      TX1=TX1+YN-EH(9,J1)                                               AN 02380
      RN=TX1/YN1                                                        AN 02390
      J2=J1                                                             AN 02400
      IF (SPHI.GE.RN) RN=1.                                             AN 02410
      SPHI=SPHI/RN                                                      AN 02420
      THET=DASIN(SPHI)                                                  AN 02430
      GO TO 5                                                           AN 02440
25    BETA=BET1                                                         AN 02450
      LEN=0.                                                            AN 02460
      FBT=FBT1                                                          AN 02470
26    THET=ANGLE+(B1-BETA)/(1.+FBT/TANG)                                AN 02480
      DBETA=BETA/CA                                                     AN 02490
      B=BET1/CA                                                         AN 02500
      TH1=THET/CA                                                       AN 02510
      WRITE(6,404) BETA,DBETA,FBT,TH1,TANG                              AN 02520
      IF (THET.GT.TN.OR.THET.LT.TM) THET=(TN+TM)/2.                     AN 02530
      TH1=THET/CA                                                       AN 02540
      WRITE(6,404) BET1,B,FBT,TH1                                       AN 02550
      TN1=TN/CA                                                         AN 02560
```

```
      TM1=TM/CA
      WRITE(6,4Ø5) TN,TM,TN1,TM1
      SPHI=DSIN(THET)
      TANG=DTAN(THET)
      IT=IT+1
      DBE=DABS(B1-BETA)
      DTH=DABS(ANGLE-THET)
      IF (IT.EQ.1Ø)  THET=Ø.5*(ANGLE+THET)
      IF (IT.EQ.1Ø) GO TO 28
      IF (DBE.GT.1.ØE-7.AND.DTH.GT.1.ØE-7) GO TO 1
28    ANGLE=THET/CA
      WRITE(6,4Ø6) ANGLE,IT
      RETURN
   29 H1=H2
      ANGLE=C/CA
      WRITE(6,4Ø6) ANGLE,IT
      RETURN
C
4ØØ   FORMAT(//18H ITERATION NUMBER ,I3,//)
4Ø1   FORMAT(I6,E16.7,8F13.8)
4Ø2   FORMAT(I4,F1Ø.4,6E13.4,4F1Ø.4/)
4Ø3   FORMAT(7H  HMIN=,F14.6,6H  DIF=,E14.6,5H  PR=,E16.8)
4Ø4   FORMAT(14H TOTAL BETA = ,E14.6,F15.6,7H,FBT = ,E14.6,7H THET =,
     XF1Ø.6,5HTANG=,F1Ø.6)
4Ø5   FORMAT(5F12.6)
4Ø6   FORMAT(8X,/1X,14HZENITH ANGLE =,F7.3,6ØH DEGREES :  RECOMPUTED
     X   FROM SUBROUTINE ANGL (ITERATION,I3,1H))
      END
```

```
      SUBROUTINE LIB(NEWS,NEWP,MAX,NFILES,XORG,YORG)
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      REAL*4 XORG,YORG
      REAL*4 XTITLE,XAXIS,XINIT,XSCALE,DXT
      REAL*4 YTITLE,YAXIS,YINIT,YSCALE,DYT
      REAL*4 TITLE
      REAL*4 Y,X
      DIMENSION XTITLE(20),YTITLE(20),TITLE(20)
      DIMENSION ARRAY(3001),V(4000),T(4000),Y(4500),X(4500)
      DIMENSION XSS(8),SS(8),NEWS(2,10),NEWP(2,10),MAX(2)
      COMMON/BLOCK1/V,T
      COMMON/BLOCK2/Y,X
      COMMON/BLOCK3/N,ARRAY,DUMMY(78)
      COMMON/XBLOCK/XTITLE,XAXIS,XINIT,XSCALE,DXT,NMINX
      COMMON/YBLOCK/YTITLE,YAXIS,YINIT,YSCALE,DYT,NMINY
      COMMON/PBLOCK/TITLE,ICHAR,JCHAR,KCHAR,NN
      COMMON/SETUP/ITYPE,ISLOT,NEWT,IPLOT,NX
C     DOUBLE PRECISION WIDTH,SHIFT
      DATA IPLOT/0/,ISLOT/0/

      DO 200 ITYPE=1,2
      REWIND 9
      IF(MAX(ITYPE).EQ.0) GO TO 200
      NMAX=MAX(ITYPE)

      DO 150 IFILE=1,NMAX
      KSLOT=NEWS(ITYPE,IFILE)
      IF(KSLOT.NE.-11) GO TO 20
      CALL SPACE
      GO TO 150
   20 READ(5,900) TITLE
      WRITE(6,901) TITLE
      CALL CRAM(TITLE,KCHAR)
      IF(KSLOT.EQ.0) GO TO 40
      LAST=ISLOT
      ISLOT=KSLOT
      JSLOT=IABS(ISLOT)
      IF(-ISLOT.EQ.LAST) GO TO 40
      GO TO (25,30,35),JSLOT
   25 READ(5,910) WIDTH,SHIFT,NS
      READ(5,920) (XSS(I),I=1,NS)
      READ(5,920) (SS(I),I=1,NS)
      GO TO 40
   30 READ(5,910) DELNU,RES,JLO,JHI
      GO TO 40
   35 CONTINUE
   40 IF(ISLOT.GT.0) GO TO 43
      NEWT=1
      GO TO 55
   43 IF(NEWP(ITYPE,IFILE).NE.0) LNEW=NEWP(ITYPE,IFILE)
      NEWT=LNEW
      IPLOT=IPLOT+1
      IF(IPLOT.NE.1) GO TO 45
      CALL INITP$(4,2)
      CALL PLOT(XORG,YORG,-3)
   45 IF(NEWP(ITYPE,IFILE).EQ.0) GO TO 50
```

```
      READ(5,9ØØ) XTITLE
      READ(5,9ØØ) YTITLE
      READ(5,93Ø) XAXIS,XINIT,XSCALE,DXT,NMINX
      READ(5,93Ø) YAXIS,YINIT,YSCALE,DYT,NMINY
      CALL CRAM(XTITLE,ICHAR)
      CALL CRAM(YTITLE,JCHAR)
C  5Ø IF(ISLOT.GT.Ø) CALL FRAME
   5Ø CONTINUE
   55 GO TO (6Ø,7Ø,8Ø),JSLOT
   6Ø WRITE(6,94Ø) WIDTH,SHIFT,NS
      WRITE(6,942) (SS(I),I=1,NS)
      WRITE(6,945) (XSS(I),I=1,NS)
      IF(ITYPE.EQ.1) WRITE(6,935)
      IF(ITYPE.EQ.2) WRITE(6,937)
      CALL GEN(WIDTH,SHIFT,XSS,SS,NS)
      GO TO 15Ø
   7Ø WRITE(6,95Ø) DELNU,RES,JLO,JHI
      IF(ITYPE.EQ.1) WRITE(6,935)
      IF(ITYPE.EQ.2) WRITE(6,937)
      CALL AFGL(DELNU,RES,JLO,JHI)
      GO TO 15Ø
   8Ø WRITE(6,96Ø)
      IF(ITYPE.EQ.1) WRITE(6,935)
      IF(ITYPE.EQ.2) WRITE(6,937)
      CALL ALL
  15Ø CONTINUE

  2ØØ CONTINUE

      IF(IPLOT.EQ.Ø) RETURN
      CALL PLOT(XAXIS+5.Ø,Ø.Ø,-3)
      CALL ENDPLT
      RETURN
  9ØØ FORMAT(2ØA4)
  9Ø1 FORMAT(/////3ØX,2ØA4)
  91Ø FORMAT(2F1Ø.5,2I1Ø)
  92Ø FORMAT(8F1Ø.5)
  93Ø FORMAT(4E1Ø.4,I1Ø)
  935 FORMAT(////1X,53X,25HATMOSPHERIC TRANSMITTANCE)
  937 FORMAT(////1X,5ØX,31HRADIATION(WATTS/SR/CM**2/UNITS))
  94Ø FORMAT(//1X,22HVARIABLE SLIT FUNCTION/1X,6HWIDTH=,F1Ø.5,4X,
     X 6HSHIFT=,F1Ø.5,4X,2ØHNO. OF DEFINING PTS=,I2)
  942 FORMAT(1X,8HYS ARE  ,8F1Ø.3)
  945 FORMAT(1X,8HXS ARE  ,8F1Ø.3)
  95Ø FORMAT(//1X,6HDELNU=,F1Ø.5,4X,4HRES=,F1Ø.5,4X,4HJLO=,
     X I5,4X,4HJHI=,I5///)
  96Ø FORMAT(//1X,25HNO SLIT FUNCTION USED           ///)
      END
```

```
      SUBROUTINE CRAM(TITLE,NCHAR)
C
C***   REMOVES TRAILING BLANKS IN TITLE   ***
C
      DIMENSION TITLE(1)
      NCHAR=8Ø
      DO 5Ø I=1,2Ø
      IWORD=21-I
      IF(TITLE(IWORD).NE.4H    ) RETURN
      NCHAR=NCHAR-4
   5Ø CONTINUE
      NCHAR=1
      RETURN
      END







      SUBROUTINE AFGL(DELNU,RES,JLO,JHI)
C PART1 - CALCULATES THE FOURIER ANALYZER INSTRUMENT FUNCTION (WINDOW +
C HANNING) FOR EVERY .Ø1 CHANNEL FROM Ø TO 3Ø CHANNELS.
C PART2 - CONVOLVES A DATA SPECTRUM (TAPE1) AT HIGH RESOLUTION (.1 CM-1)
C WITH THE F.A. INSTRUMENT FUNCTION.
C INSTR.FUNCT= .25*(SINC(PI*(X-1))+SINC(PI*(X+1)))+.5*SINC(PI*X)
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      INTEGER*4 N,JJ
      REAL*4 XTITLE,XAXIS,XINIT,XSCALE,DXT
      REAL*4 YTITLE,YAXIS,YINIT,YSCALE,DYT
      REAL*4 TITLE
      REAL*4 A,VV
      DIMENSION XTITLE(2Ø),YTITLE(2Ø),TITLE(2Ø)
      DIMENSION ARRAY(3ØØ1),V(4ØØØ),T(4ØØØ),A(45ØØ),VV(45ØØ)
      COMMON/BLOCK1/V,T
      COMMON/BLOCK2/A,VV
      COMMON/BLOCK3/KKK,ARRAY,DUMMY(78)
      COMMON/XBLOCK/XTITLE,XAXIS,XINIT,XSCALE,DXT,NMINX
      COMMON/YBLOCK/YTITLE,YAXIS,YINIT,YSCALE,DYT,NMINY
      COMMON/PBLOCK/TITLE,ICHAR,JCHAR,KCHAR,NN
      COMMON/SETUP/ITYPE,ISLOT,NEWT,IPLOT,JWT

      NN=Ø
C BEGINNING PART1
      PI=3.14159265358979
      ARRAY(1)=Ø.5
      DO 2ØØ I=2,1ØØ
      X=(I-1)/1ØØ.
      X1=PI*(X-1.)
      X2=PI*X
      X3=PI*(X+1.)
      ARRAY(I)=.25*(DSIN(X1)/X1+DSIN(X3)/X3)+.5*DSIN(X2)/X2
  2ØØ CONTINUE
      ARRAY(1Ø1)=Ø.25
      DO 21Ø I=1Ø2,3ØØ1
```

```
      X=(I-1)/1ØØ.
      X1=PI*(X-1.)
      X2=PI*X
      X3=PI*(X+1.)
      ARRAY(I)=.25*(DSIN(X1)/X1+DSIN(X3)/X3)+.5*DSIN(X2)/X2
  21Ø CONTINUE
C BEGINNING PART2
C CONVOLVE OVER 3Ø CHANNEL RANGE ONLY
C CALCULATE INSTR FUNCT. TO NEAREST .Ø1 CHANNEL BY USING ARRAY LIBRARY
C READ SPECTRUM
C DELNU(CM-1) BETWEEN CHANNELS, LASER SAMPLING INTERVAL IN WAVENUMBERS
C JLO LOWEST OUTPUT CHANNEL, JLO*DELNU WAVENUMBER
C JHI HIGHEST OUTPUT CHANNEL, JHI*DELNU WAVENUMBER
      DO 5Ø J=1,5ØØ
   5Ø A(J)=Ø.
   52 READ(9,54) H1,H2
   54 FORMAT(2F1Ø.2)
      IF(H1.EQ.-1.Ø) GO TO 12Ø
   55 READ(9,58) JWT,V(1),V(JWT),DVM
   58 FORMAT(I1Ø,3F1Ø.4)
      IF(ITYPE.EQ.1) READ(9,56)(V(J),DUM,T(J),J=1,JWT)
      IF(ITYPE.EQ.2) READ(9,56)(V(J),T(J),DUM,J=1,JWT)
   56 FORMAT(F12.4,2E12.4)
      DO 1ØØ J=1,JWT
      X1=V(J)/DELNU
      N=X1
      N1=N-29
      IF(N1.LT.JLO) N1=JLO
      N2=N+3Ø
      IF(N2.GT.JHI) N2=JHI
      DO 11Ø I=N1,N2
      X=DABS((X1-FLOAT(I))*1ØØ.)+1
      JJ=X
      K=I-JLO+1
  11Ø A(K)=A(K)+T(J)*((ARRAY(JJ+1)-ARRAY(JJ))*(X-JJ)+ARRAY(JJ))
  1ØØ CONTINUE
      GO TO 52
  12Ø KK=JHI-JLO+1
      KKK=Ø
      DO 4ØØ K=1,KK
      KKK=KKK+1
      A(KKK)=A(K)*RES/DELNU
      I=JLO+K-1
      VV(KKK)=I*DELNU+DELNU/2.Ø
      IF(KKK.EQ.24Ø) CALL PROUT
  4ØØ CONTINUE
      CALL PROUT
      RETURN
      END
```

```
      SUBROUTINE GEN(WIDTH,SHIFT,XSS,SS,NS)
C
C***   SLIT FUNCTION   ***
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      REAL*4 XTITLE,XAXIS,XINIT,XSCALE,DXT
      REAL*4 YTITLE,YAXIS,YINIT,YSCALE,DYT
      REAL*4 TITLE
      REAL*4 Y,X
      DIMENSION ARRAY(3ØØ1),XF(4ØØØ),F(4ØØØ),Y(45ØØ),X(45ØØ)
      DIMENSION XTITLE(2Ø),YTITLE(2Ø),TITLE(2Ø)
      DIMENSION XS(8),S(8),XSS(1),SS(1)
      COMMON/BLOCK1/XF,F
      COMMON/BLOCK2/Y,X
      COMMON/BLOCK3/N,ARRAY,DUMMY(78)
      COMMON/XBLOCK/XTITLE,XAXIS,XINIT,XSCALE,DXT,NMINX
      COMMON/YBLOCK/YTITLE,YAXIS,YINIT,YSCALE,DYT,NMINY
      COMMON/PBLOCK/TITLE,ICHAR,JCHAR,KCHAR,NN
      COMMON/SETUP/ITYPE,ISLOT,NEWT,IPLOT,NF
C     DOUBLE PRECISION A,B,C,D,AA,BB,CC,DELX,DELF,DELS,DEL3,DEL2,DEL1
C     DOUBLE PRECISION X1,S1,F1,X2,S2,F2,XNEXT,XMID,XSTOP,XTOP,WIDTH
C     DOUBLE PRECISION SUM,XSF,SHIFT,XS,XFS,XFIF,XSF1,XSEND,XSTRT
C     DOUBLE PRECISION XDEL,AREA,PART,SF


      FAC=WIDTH/(XSS(NS)-XSS(1))
      DO 5 IS=1,NS
      XS(IS)=FAC*XSS(IS)
      S(IS)=FAC*SS(IS)
    5 CONTINUE

      AREA=Ø.Ø
      DO 1Ø IS=2,NS
      IS1=IS-1
      AREA=AREA+(S(IS)+S(IS1))*(XS(IS)-XS(IS1))/2.Ø
   1Ø CONTINUE

      NN=Ø
      N=Ø


   32 READ(9,33) H1,H2
   33 FORMAT(2F1Ø.2)
      IF(H1.NE.-1.Ø) GC TO 34
      CALL PROUT
      RETURN
   34 READ(9,35) NF,XF(1),XF(NF),DVM
   35 FORMAT(I1Ø,3F1Ø.4)
      IF(ITYPE.EQ.1) READ(9,36)(XF(J),DUM,F(J),J=1,NF)
      IF(ITYPE.EQ.2) READ(9,36)(XF(J),F(J),DUM,J=1,NF)
   36 FORMAT(F12.4,2E12.4)


   39 XTOP=XF(NF)
      XDEL=SHIFT+XS(1)
```

```
      XSTRT=XS(1)
      XSEND=XS(NS)
      XMID=XF(1)-XS(1)-SHIFT
      MF=1

   4Ø IF=MF

      XMID=XMID+SHIFT
      XNEXT=XMID+XDEL
      XSTOP=XMID+XSEND

      SUM=Ø.Ø
      X2=XMID+XSTRT
      S2=S(1)

      IF1=IF+1
      F2=F(IF)+(F(IF1)-F(IF))*(X2-XF(IF))/(XF(IF1)-XF(IF))


      IS=1
      XSF=XMID+XSTRT

   5Ø X1=X2
      S1=S2
      F1=F2

      IF(XF(IF).GT.X1) GO TO 7Ø
      IF=IF+1

   7Ø IF(XF(IF).LE.XNEXT) MF=IF
      XSF1=XSF-X1
      IF(XSF1.GT.Ø.Ø) GO TO 8Ø
      IS=IS+1
      XSF=XMID+XS(IS)

   8Ø XFIF=XF(IF)
      X2=DMIN1(XFIF,XSF)
      XFS=X2-XMID

      IS1=IS-1
      IF1=IF-1
      S2=S(IS1)+(S(IS)-S(IS1))*(XFS-XS(IS1))/(XS(IS)-XS(IS1))
      F2=F(IF1)+(F(IF)-F(IF1))*(X2-XF(IF1))/(XF(IF)-XF(IF1))

      DELX=X2-X1
      DELF=F2-F1
      DELS=S2-S1

      A=DELS/DELX
      B=S1
      C=DELF/DELX
      D=F1

      AA=A*C/3.Ø
      BB=(A*D+B*C)/2.Ø
      CC=B*D
```

```
      DEL3=DELX**3
      DEL2=DELX**2
      DEL1=DELX



      SUM=SUM+AA*DEL3+BB*DEL2+CC*DEL1

      IF(X2.LT.XTOP) GO TO 85
      IF(XSTOP.GT.XTOP) GO TO 1ØØ
      N=N+1
      X(N)=XMID
      Y(N)=SUM/AREA
      IF(N.EQ.24Ø) CALL PROUT
      GO TO 32



   85 IF(X2.LT.XSTOP) GO TO 5Ø
      N=N+1
      X(N)=XMID
      Y(N)=SUM/AREA
      IF(N.EQ.24Ø) CALL PROUT
      GO TO 4Ø


  1ØØ XFS=X2-XMID
      PART=Ø.Ø
      IS=1

  1Ø5 IS1=IS+1
      IF(XS(IS1).LT.XFS) GO TO 11Ø
      SF=S(IS)+(S(IS1)-S(IS))*(XFS-XS(IS))/(XS(IS1)-XS(IS))
      PART=PART+(SF+S(IS))*(XFS-XS(IS))/2.Ø
      GO TO 115

  11Ø PART=PART+(S(IS1)+S(IS))*(XS(IS1)-XS(IS))/2.Ø
      IS=IS+1
      GO TO 1Ø5

  115 N=N+1
      X(N)=XMID
      Y(N)=SUM/PART
      IF(N.EQ.24Ø) CALL PROUT
      GO TO 32


      END
```

```
      SUBROUTINE FRAME
C
C***   SETS UP FRAME FOR PLOT   ***
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      REAL*4 XTITLE,XAXIS,XINIT,XSCALE,DXT
      REAL*4 YTITLE,YAXIS,YINIT,YSCALE,DYT
      REAL*4 TITLE
      DIMENSION XTITLE(2Ø),YTITLE(2Ø),TITLE(2Ø)
      COMMON/XBLOCK/XTITLE,XAXIS,XINIT,XSCALE,DXT,NMINX
      COMMON/YBLOCK/YTITLE,YAXIS,YINIT,YSCALE,DYT,NMINY
      COMMON/PBLOCK/TITLE,ICHAR,JCHAR,KCHAR,NN
      COMMON/SETUP/ITYPE,ISLOT,NEWT,IPLOT,NX
      IF(IPLOT.GT.1) CALL PLOT(XAXIS+5.Ø,Ø.Ø,-3)
      CALL AXIS(Ø.Ø,Ø.Ø,XTITLE,-ICHAR,XAXIS,Ø.Ø,XINIT,XSCALE,DXT,NMINX)
      CALL AXIS(Ø.Ø,YAXIS,TITLE,+KCHAR,XAXIS,Ø.Ø,XINIT,XSCALE,DXT,NMINX)
      CALL AXIS(Ø.Ø,Ø.Ø,YTITLE,+JCHAR,YAXIS,9Ø.Ø,YINIT,YSCALE,DYT,NMINY)
      CALL AXIS(XAXIS,Ø.Ø,4H    ,-4,YAXIS,9Ø.Ø,YINIT,YSCALE,DYT,NMINY)
      RETURN
      END




      SUBROUTINE PROUT
C
C***   PRINT OUTPUT AND PLOT CURVES   ***
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      REAL*4 XPT,YPT
      REAL*4 XTITLE,XAXIS,XINIT,XSCALE,DXT
      REAL*4 YTITLE,YAXIS,YINIT,YSCALE,DYT
      REAL*4 TITLE,TNORM1,TNORM2,TEXP
      REAL*4 Y,X,YMAX,YCHECK
      DIMENSION XTITLE(2Ø),YTITLE(2Ø),TITLE(2Ø),TNORM1(5)
      DIMENSION V(6ØØ),W(6ØØ),T(6ØØ),RV(6ØØ),RW(6ØØ)
      DIMENSION XX(4ØØØ),YY(4ØØØ),Y(45ØØ),X(45ØØ)
      COMMON/BLOCK1/XX,YY
      COMMON/BLOCK2/Y,X
      COMMON/BLOCK3/N,V,W,T,RV,RW,DUMMY(79)
      COMMON/XBLOCK/XTITLE,XAXIS,XINIT,XSCALE,DXT,NMINX
      COMMON/YBLOCK/YTITLE,YAXIS,YINIT,YSCALE,DYT,NMINY
      COMMON/PBLOCK/TITLE,ICHAR,JCHAR,KCHAR,NN
      COMMON/SETUP/ITYPE,ISLOT,NEWT,IPLOT,NX
      DATA TNORM1/4H  NO,4HRMAL,4HIZED,4H TO ,4H1Ø.(/
      DATA TNORM2/4H)   /

      IF(N.EQ.Ø) RETURN
      IF(ISLOT.LT.Ø) GO TO 5
      IF(NEWT.GT.Ø) GO TO 3
      IF(ITYPE.EQ.2) GO TO 75Ø
      DO 72Ø I=1,N
      X(I)=1.ØE+Ø4/X(I)
  72Ø CONTINUE
      GO TO 3
  75Ø DO 8ØØ I=1,N
```

```
      Y(I)=1.ØE-Ø4*Y(I)*X(I)**2                                         PR ØØ33Ø
      X(I)=1.ØE+Ø4/X(I)                                                 PR ØØ34Ø
  8ØØ CONTINUE                                                          PR ØØ35Ø
    3 CONTINUE                                                          PR ØØ36Ø
      YMAX=Y(1)                                                         PR ØØ37Ø
      DO 4 I=2,N                                                        PR ØØ38Ø
    4 YMAX=AMAX1(Y(I),YMAX)                                             PR ØØ39Ø
      YCHECK=YINIT+YAXIS*YSCALE                                         PR ØØ4ØØ
      IF(YMAX.LE.YCHECK) IEXP=INT(ALOG1Ø(YCHECK))-1                     PR ØØ41Ø
      IF(YMAX.GT.YCHECK) IEXP=INT(ALOG1Ø(YMAX))-1                       PR ØØ42Ø
      IF(IEXP.EQ.-1) IEXP=Ø                                             PR ØØ43Ø
      YINIT=YINIT/1Ø.**IEXP                                             PR ØØ44Ø
      IF(YMAX.GT.YCHECK) YMAX=INT(YMAX/1Ø.**IEXP+.9999)                 PR ØØ45Ø
      IF(YMAX.GT.YCHECK) YSCALE=(YMAX-YINIT)/YAXIS                      PR ØØ46Ø
      IF(YMAX.LE.YCHECK) YSCALE=YSCALE/1Ø.**IEXP                        PR ØØ47Ø
      IF(YMAX.GT.YCHECK) DYT=YSCALE                                     PR ØØ48Ø
      IF(YMAX.LE.YCHECK) DYT=DYT/1Ø.**IEXP                              PR ØØ49Ø
      DO 6 I=1,N                                                        PR ØØ5ØØ
    6 Y(I)=Y(I)/1Ø.**IEXP                                               PR ØØ51Ø
      X(N+1)=XINIT                                                      PR ØØ52Ø
      X(N+2)=XSCALE                                                     PR ØØ53Ø
      Y(N+1)=YINIT                                                      PR ØØ54Ø
      Y(N+2)=YSCALE                                                     PR ØØ55Ø
      IF(ISLOT.LE.Ø) GO TO 8                                            PR ØØ56Ø
      CALL FRAME                                                        PR ØØ57Ø
      IF(IEXP.EQ.Ø) GO TO 8                                             PR ØØ58Ø
      CALL SYMBOL(XAXIS+1.,3.*YAXIS/4Ø.,YAXIS/4Ø.,TNORM1,9Ø.Ø,2Ø)       PR ØØ59Ø
      CALL WHERE(XNORM,YNORM)                                           PR ØØ6ØØ
      TEXP=IEXP                                                         PR ØØ61Ø
      CALL NUMBER(XNORM,YNORM,YAXIS/4Ø.,TEXP,9Ø.Ø,-1)                   PR ØØ62Ø
      CALL WHERE(XNORM,YNORM)                                           PR ØØ63Ø
      CALL SYMBOL(XNORM,YNORM,YAXIS/4Ø.,TNORM2,9Ø.Ø,4)                  PR ØØ64Ø
    8 CALL LINE(X,Y,N,1,Ø,Ø)                                            PR ØØ65Ø
      DO 7 I=1,N                                                        PR ØØ66Ø
    7 Y(I)=Y(I)*1Ø.**IEXP                                               PR ØØ67Ø
    5 IF(ITYPE.EQ.2) GO TO 5ØØ                                          PR ØØ68Ø
      WRITE(6,9Ø3)                                                      PR ØØ69Ø
  9Ø3 FORMAT(////1X,6HLAMBDA,7X,1HV,9X,13HTRANSMITTANCE,11X,            PR ØØ7ØØ
     X 6HLAMBDA,7X,1HV,9X,13HTRANSMITTANCE,11X,6HLAMBDA,7X,1HV,         PR ØØ71Ø
     X 9X,13HTRANSMITTANCE)                                             PR ØØ72Ø
      WRITE(6,9Ø4)                                                      PR ØØ73Ø
  9Ø4 FORMAT(1X,7HMICRONS,4X,4HCM-1,32X,7HMICRONS,4X,                   PR ØØ74Ø
     X 4HCM-1,32X,7HMICRONS,4X,4HCM-1)                                  PR ØØ75Ø
      K=N/3                                                             PR ØØ76Ø
      NK=3*K                                                            PR ØØ77Ø
      IF(NEWT.GT.Ø) GO TO 3Ø                                            PR ØØ78Ø
      DO 2Ø I=1,N                                                       PR ØØ79Ø
      IF(I.LE.NK) GO TO 1Ø                                              PR ØØ8ØØ
      L=I                                                               PR ØØ81Ø
      GO TO 15                                                          PR ØØ82Ø
   1Ø I1=I-1                                                            PR ØØ83Ø
      IROW=MOD(I1,K )+1                                                 PR ØØ84Ø
      JCOL=I1/K+1                                                       PR ØØ85Ø
      L=3*IROW+JCOL-3                                                   PR ØØ86Ø
   15 V(L)=1.ØE+Ø4/X(I)                                                 PR ØØ87Ø
```

```
      W(L)=X(I)                                                         PR ØØ88Ø
      T(L)=Y(I)                                                         PR ØØ89Ø
   2Ø CONTINUE                                                          PR ØØ9ØØ
      GO TO 8Ø                                                          PR ØØ91Ø
   3Ø DO 4Ø I=1,N                                                       PR ØØ92Ø
      IF(I.LE.NK) GO TO 33                                              PR ØØ93Ø
      L=I                                                               PR ØØ94Ø
      GO TO 37                                                          PR ØØ95Ø
   33 I1=I-1                                                            PR ØØ96Ø
      IROW=MOD(I1,K )+1                                                 PR ØØ97Ø
      JCOL=I1/K+1                                                       PR ØØ98Ø
      L=3*IROW+JCOL-3                                                   PR ØØ99Ø
   37 V(L)=X(I)                                                         PR Ø1ØØØ
      W(L)=1.ØE+Ø4/X(I)                                                 PR Ø1Ø1Ø
      T(L)=Y(I)                                                         PR Ø1Ø2Ø
   4Ø CONTINUE                                                          PR Ø1Ø3Ø
   8Ø WRITE(6,9Ø8)(W(L),V(L),T(L),T(L),L=1,NK)                          PR Ø1Ø4Ø
  9Ø8 FORMAT(1X,F7.4,3X,F7.2,5X,F4.2,5X,F7.5,9X,                        PR Ø1Ø5Ø
     X F7.4,3X,F7.2,5X,F4.2,5X,F7.5,9X,F7.4,3X,                         PR Ø1Ø6Ø
     X F7.2,5X,F4.2,5X,F7.5)                                            PR Ø1Ø7Ø
      IF(NK.EQ.N) GO TO 85                                              PR Ø1Ø8Ø
      N1=NK+1                                                           PR Ø1Ø9Ø
      WRITE(6,9Ø9)(W(L),V(L),T(L),T(L),L=N1,N)                          PR Ø11ØØ
  9Ø9 FORMAT(95X,F7.4,3X,F7.2,5X,F4.2,5X,F7.5)                          PR Ø111Ø
   85 N=Ø                                                               PR Ø112Ø
      RETURN                                                            PR Ø113Ø
  5ØØ WRITE(6,912)                                                      PR Ø114Ø
  912 FORMAT(////4X,1HV,6X,9HRADIATION,4X,6HLAMBDA,2X,9HRADIATION,8X,   PR Ø115Ø
     X 1HV,6X,9HRADIATION,4X,6HLAMBDA,2X,9HRADIATION,8X,                PR Ø116Ø
     X 1HV,6X,9HRADIATION,4X,6HLAMBDA,2X,9HRADIATION)                   PR Ø117Ø
      WRITE(6,914)                                                      PR Ø118Ø
  914 FORMAT(3X,4HCM-1,4X,8HPER CM-1,4X,7HMICRONS,3X,6HPER UM,9X,       PR Ø119Ø
     X 4HCM-1,4X,8HPER CM-1,4X,7HMICRONS,3X,6HPER UM,9X                 PR Ø12ØØ
     X 4HCM-1,4X,8HPER CM-1,4X,7HMICRONS,3X,6HPER UM)                   PR Ø121Ø
      K=N/3                                                             PR Ø122Ø
      NK=3*K                                                            PR Ø123Ø
      IF(NEWT.GT.Ø) GO TO 53Ø                                           PR Ø124Ø
      DO 52Ø I=1,N                                                      PR Ø125Ø
      IF(I.LE.NK) GO TO 51Ø                                             PR Ø126Ø
      L=I                                                               PR Ø127Ø
      GO TO 515                                                         PR Ø128Ø
  51Ø I1=I-1                                                            PR Ø129Ø
      IROW=MOD(I1,K )+1                                                 PR Ø13ØØ
      JCOL=I1/K+1                                                       PR Ø131Ø
      L=3*IROW+JCOL-3                                                   PR Ø132Ø
  515 V(L)=1.ØE+Ø4/X(I)                                                 PR Ø133Ø
      RV(L)=Y(I)*X(I)/V(L)                                              PR Ø134Ø
      W(L)=X(I)                                                         PR Ø135Ø
      RW(L)=Y(I)                                                        PR Ø136Ø
  52Ø CONTINUE                                                          PR Ø137Ø
      GO TO 58Ø                                                         PR Ø138Ø
  53Ø DO 54Ø I=1,N                                                      PR Ø139Ø
      IF(I.LE.NK) GO TO 533                                             PR Ø14ØØ
      L=I                                                               PR Ø141Ø
```

```
      GO TO 537                                                         PR Ø142Ø
  533 I1=I-1                                                            PR Ø143Ø
      IROW=MOD(I1,K )+1                                                 PR Ø144Ø
      JCOL=I1/K+1                                                       PR Ø145Ø
      L=3*IROW+JCOL-3                                                   PR Ø146Ø
  537 V(L)=X(I)                                                         PR Ø147Ø
      RV(L)=Y(I)                                                        PR Ø148Ø
      W(L)=1.ØE+Ø4/X(I)                                                 PR Ø149Ø
      RW(L)=Y(I)*X(I)/W(L)                                              PR Ø15ØØ
  54Ø CONTINUE                                                          PR Ø151Ø
  58Ø WRITE(6,985) (V(L),RV(L),W(L),RW(L),L=1,NK)                       PR Ø152Ø
  985 FORMAT(1X,ØPF7.2,2X,PE1Ø.4,3X,ØPF7.4,2X,PE9.3,5X                  PR Ø153Ø
     X ØPF7.2,2X,PE1Ø.4,3X,ØPF7.4,2X,PE9.3,5X,                          PR Ø154Ø
     X ØPF7.2,2X,PE1Ø.4,3X,ØPF7.4,2X,PE9.3)                             PR Ø155Ø
      IF(NK.EQ.N) GO TO 545                                             PR Ø156Ø
      N1=NK+1                                                           PR Ø157Ø
      WRITE(6,988) (V(L),RV(L),W(L),RW(L),L=N1,N)                       PR Ø158Ø
  988 FORMAT(91X,ØPF7.2,2X,PE1Ø.4,3X,ØPF7.4,2X,PE9.3)                   PR Ø159Ø
  545 N=Ø                                                               PR Ø16ØØ
      RETURN                                                            PR Ø161Ø
      END                                                               PR Ø162Ø
                                                                        PR Ø163Ø
                                                                        PR Ø164Ø
                                                                        PR Ø165Ø
                                                                        PR Ø166Ø
                                                                        PR Ø167Ø
                                                                        PR Ø168Ø
                                                                        PR Ø169Ø
                                                                        PR Ø17ØØ
                                                                        PR Ø171Ø
                                                                        PR Ø172Ø
                                                                        PR Ø173Ø
```

```
      SUBROUTINE SPACE
C
C***   SKIPS OVER DATA SETS ON FILE 9    ***
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
   52 READ(9,54) DUM1,DUM2
   54 FORMAT(2F10.2)
      IF(DUM1.EQ.-1.0) RETURN
      READ(9,58) N,DUM,DUM,DUM
   58 FORMAT(I10,3F10.4)
      READ(9,59) (DUM,DUM,DUM,I=1,N)
   59 FORMAT(F12.4,2E12.4)
      GO TO 52
      END
```

```
      SUBROUTINE ALL
C
C***   PRINTS/PLOTS UNDEGRADED SPECTRUM   ***
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      REAL*4 XTITLE,XAXIS,XINIT,XSCALE,DXT
      REAL*4 YTITLE,YAXIS,YINIT,YSCALE,DYT
      REAL*4 TITLE
      REAL*4 Y,X
      DIMENSION ARRAY(3001),XF(4000),F(4000),Y(4500),X(4500)
      DIMENSION XTITLE(20),YTITLE(20),TITLE(20)
      COMMON/BLOCK1/XF,F
      COMMON/BLOCK2/Y,X
      COMMON/BLOCK3/N,ARRAY,DUMMY(78)
      COMMON/XBLOCK/XTITLE,XAXIS,XINIT,XSCALE,DXT,NMINX
      COMMON/YBLOCK/YTITLE,YAXIS,YINIT,YSCALE,DYT,NMINY
      COMMON/PBLOCK/TITLE,ICHAR,JCHAR,KCHAR,NN
      COMMON/SETUP/ITYPE,ISLOT,NEWT,IPLOT,NF

      NN=0
      N=0
   32 READ(9,33) H1,H2
   33 FORMAT(2F10.2)
      IF(H1.NE.-1.0) GO TO 34
      CALL PROUT
      RETURN
   34 READ(9,35) NF,XF(1),XF(NF),DVM
   35 FORMAT(I10,3F10.4)
      IF(ITYPE.EQ.1) READ(9,36)(XF(J),DUM,F(J),J=1,NF)
      IF(ITYPE.EQ.2) READ(9,36)(XF(J),F(J),DUM,J=1,NF)
   36 FORMAT(F12.4,2E12.4)
   39 DO 100 J=1,NF
      N=N+1
      X(N)=XF(J)
      Y(N)=F(J)
      IF(N.EQ.240) CALL PROUT
  100 CONTINUE
      GO TO 32
      END
```

APPENDIX B
MRDAT PROGRAM LISTING

```
      PROGRAM MRDAT(INPUT,OUTPUT,TAPE2,TAPE4,TAPE6=OUTPUT,TAPE5=INPUT,


      PROGRAM MRDAT(INPUT,OUTPUT,TAPE2,TAPE4,TAPE6=OUTPUT,TAPE5=INPUT,
     X TAPE11,TAPE12,TAPE13)
C
C        MAY 9 77   HITRAN MODIFIED FOR BLUE CO2 ARC TABLES
C   JUNE 23 --  VOIGHT PROFILE AND FORM FACTOR
C  JULY 77 MODIFIED FOR RED CO2 REGION
C  AUG 77 REWRITTEN FO MRDA
      LOGICAL LCHK,LOGIC
      DIMENSION SUM1(6,9,1Ø1),SUM2(6,9,1Ø1),OMEGB(1Ø1),
     KSPECIE(7),AMASS(7),JCALC(7)
      DIMENSION CAY3(6,9),CS1(9),CS2(7,9),CA(9)
      COMMON/INPUT/ P(1Ø),T(1Ø),W(7),V1,V2,DV,VLWST,VHGHST,DELTV,
     KBOUND,NPTPTS,MSPEC(7),SSTR,VBLOCK,DV2
      COMMON/OMG/ OMEGA(2Ø1,6),STOR(6,9,3Ø4)
      COMMON/LINES/ GNU(25Ø),S(25Ø),ALPHA(25Ø),EDP(25Ø),MOL(25Ø),
     KLCHK(25Ø),TI(25Ø,9),ITI(25Ø),TMAX
      COMMON/BLOCK1/MAX,CS1,CS2,CA,SUM1,SUM2,OMEGB,JMAX,NFILES
      DATA AMASS/18.,44.,48.,44.,28.,16.,32./
      DATA SPECIE/4HH2O ,4HCO2 ,4HO3  ,4HN2O ,4HCO  ,4HCH4 ,4HO2  /
C
      PI=3.14159
      PØ=1Ø13.
      TØ=296.
C
      MAX=6
      VSTEP=5Ø.Ø
      SLOWER=1.ØE-27

C**   ROOT OF MOLECULAR WT FOR DOPPLER LINESHAPE
      DO 1 M=1,7
    1 AMASS(M)=SQRT(AMASS(M))
C
C ***  THESE DEFINTIONS ARE NOT ACCURATE
C     READ INPUT PARAMETERS (P=PRESSURE), (T=TEMPERATURE),
C     W(1)=H2Ø, W(2)=CØ2,W(3)=Ø3,W(4)=N2Ø,W(5)=CØ,W(6)=CH4,W(7)=Ø2.
C     V1 AND V2 ARE FREQUENCY LIMITS FOR WHICH OUTPUT RESULTS ARE REQUIR
C     DV IS MONOCHROMATIC FREQUENCY INCREMENT.
C     BOUND IS THE FREQUENCY FROM ANY LINE CENTER BEYOND WHICH THE LINE
C
C ***  DEFINE MOLECULAR SPECIES
C ***  READ INITIAL PARAMETERS
      CALL DATIN
      WRITE(4,3) V1,V2,NPTPTS
    3 FORMAT(2F1Ø.2,I5)
      WRITE(4,4)(P(I),I=1,NPTPTS)
      WRITE(4,4)(T(I),I=1,NPTPTS)
    4 FORMAT(9F1Ø.2)
C ***  CALCULATE CONTRIBUTION OF DISTANT LINES
C ****  FIRST DETERMINE OMEGBS (CALCULATIONAL POINTS)
    5 VBOT=FLOAT(INT(V1))
      VTOP=FLOAT(INT(V2) )
      IF(VTOP.GT.236Ø.Ø.AND.VBOT.LT.236Ø.Ø) VTOP=236Ø.Ø
      IF (VTOP.LT.V2) VTOP=VTOP+1.Ø
      JMAX = INT((VTOP-VBOT)/DELTV+1.ØØØØ1)
C ***  JMAX MUST BE .LE. 1Ø1
      IF (JMAX .LE. 1Ø1) GO TO 8
```

```
      JMAX = 1Ø1
      VTOP=VBOT + 1ØØ.*DELTV
8     VVTOP=VTOP
      VO= VBOT
      VLWST=VBOT-VSTEP
      IF(VO.GT.236Ø.Ø) VLWST=225Ø.Ø
      VHGHST=VTOP + VSTEP
      DO 1Ø J=1,JMAX
1Ø    OMEGB(J)=VO+ (J-1)*DELTV
C****  (SUM1,SUM2)=(LEFT,RIGHT) SIDE OF REGION
C ***ZERO SUM?S -- READ TAPE -- CALCULATE
      DO 12 MM=1,MAX
      DO 12 NPT=1,NPTPTS
      DO 12 J=1,JMAX
      SUM1(MM,NPT,J)=Ø.Ø
12    SUM2(MM,NPT,J)=Ø.Ø
C
      DO 3Ø MM=1,MAX
      M=MSPEC(MM)
      IF (M.LE.Ø) GO TO 3Ø
C ***  LOGIC IS FOR TEMP DEP OF LINESTRENGTH
      LOGIC=.FALSE.
      IF(M.EQ.1.OR.M.EQ.3.OR.M.EQ.6) LOGIC=.TRUE.
C*** PRESSURE, TEMPERATURE LOOP
      DO 28 NPT=1,NPTPTS
C*** (P,T) COMPUTE DEPENDENCE OF LINE PARAMETERS
      CS1(NPT)=(TØ-T(NPT))/(TØ*T(NPT)*Ø.6946)
      WT=SQRT(TØ/T(NPT))
      CS2(M,NPT)=TØ/T(NPT)
      IF(LOGIC) CS2(M,NPT)=CS2(M,NPT)*WT
      CA(NPT)=WT*P(NPT)/PØ
28    CONTINUE
3Ø    CONTINUE

      CALL REDLIN(VBOT,VTOP)
C
C ***   CALCULATION OF FAR LINES IS COMPLETED
      M=1
      DO 33 J=1,JMAX
      WRITE(6,34) SPECIE(M),OMEGB(J),(SUM1(M,NPT,J),SUM2(M,NPT,J),NPT=1
     * ,5)
34    FORMAT(A5,F1Ø.3,5(2X,2E9.3))
      M=M+1
      IF(M.GT.5) M=5
33    CONTINUE
C
C***  CALCULATE NEAR LINES
C ***  CALL STRONG FOR CALCULATIONAL POINTS (OMEGA?S)
      REWIND 13
      VTOP=V1+VBLOCK
      DO 365 IFILE=1,NFILES
      REWIND 11
      VBOT=V1-BOUND
      IF(VTOP.GT.VVTOP) VTOP=VVTOP
      IF(VTOP.GT.V2) VTOP=V2
      NREC=Ø
```

```
340   CONTINUE
C*CDC READ(13) N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
      READ(13,END=350) N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I),I=1,N)
C*CDC IF(EOF(13)) 350,345
345   NREC=NREC+1
      WRITE(11)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I),I=1,N)
      GO TO 340
  350 WRITE(4,302) V1,VTOP
  302 FORMAT(2F10.2)
      CALL STRONG(MSPEC,V1,VTOP,DV,DV2,JCALC,SSTR,MAX,NREC)
      VTOP = VTOP+BOUND
C***  ZERO STOR---READ TAPE --- CALCULATE
      DO 35 MM=1,MAX
      DO 35 NPT=1,NPTPTS
      JMAX=JCALC(MM)
      DO 35 J=1,JMAX
35    STOR(MM,NPT,J)=0.0
      REWIND 11
      DO 55 IREC=1,NREC
      READ(11)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I),I=1,N)
      DO 48 NPT=1,NPTPTS
      DO 46 L=1,N
      M=MOL(L)
      DO 37 MM=1,MAX
      IF(M.EQ.MSPEC(MM)) GO TO 52
   37 CONTINUE
      GO TO 46
   52 SO=S(L)*CS2(M,NPT)*EXP(-EDP(L)*CS1(NPT))
      AL=ALPHA(L)*CA(NPT)
      AD=.3581E-6*GNU(L)*WT
      ARAT= .83255*AL/AD
C***  LOOP OVER CALCULATIONAL POINTS (OMEGA?S)
      K=1
      JMAX=JCALC(MM)
      DO 44 J=1,JMAX
      V=OMEGA(J,MM)
C ***    DETERMINE RANGE FOR ACCEPTING LINES
38    VLEFT=OMEGB(K)
      IF (VLEFT+DELTV-V) 39,40,40
39    K=K+1
      GO TO 38
40    Z1=ABS(VLEFT-GNU(L))
      IF (Z1.LT.BOUND) GO TO 42
      Z2=ABS(VLEFT+DELTV-GNU(L))
      IF (Z2.GT.BOUND) GO TO 44
C*** IF LINE WITHIN "BOUND" OF INTERVAL, INCLUDE IT IN CALCULATION
42    Z=ABS(V-GNU(L))
      ETA=.83255*Z/AD
      CALL ABSORB(AL,AD,ETA,ARAT,Z,AK)
      FAC=SO*AK
C**  CO2 FORM FACTOR
      IF(M.EQ.2) FAC=FAC*FORM(Z,M)
      STOR(MM,NPT,J)=STOR(MM,NPT,J)+FAC
```

```
44     CONTINUE
46     CONTINUE
48     CONTINUE
C ***    MORE LINES ????
   55 CONTINUE
C
C *** , NEARBY REGIONS ARE NOW CALCULATED
C
C ***    COMBINE RESULTS
       DO 8Ø MM=1,MAX
       M = MSPEC(MM)
       K = 1
       JMAX = JCALC(MM)
       DO 68 J=1,JMAX
       V=OMEGA(J,MM)
62     VLEFT=OMEGB(K)
       IF (VLEFT+DELTV-V) 63,64,64
63     K=K+1
       GO TO 62
64     CONTINUE
       DO 66 NPT=1,NPTPTS
       FAC1=SUM1(MM,NPT,K)
       FAC2=SUM2(MM,NPT,K)
       STOR(MM,NPT,J)=STOR(MM,NPT,J)+FAC1+(FAC2-FAC1)*(V-VLEFT)/DELTV
66     STOR(MM,NPT,J) = STOR(MM,NPT,J)*W(M)
68     CONTINUE
C
C*******    WRITE TABLE FOR MRDA
C
       WRITE (4,22Ø) SPECIE(M),JMAX
C       WRITE(6,222) SPECIE(M),JMAX
C222    FORMAT (1X,A4,I5)
22Ø    FORMAT (A4,I5)
       DO 74 J=1,JMAX
C      WRITE(6,226) OMEGA(J,MM),(STOR(MM,NPT,J),NPT=1,NPTPTS)
       WRITE (4,226) OMEGA(J,MM),(STOR(MM,NPT,J),NPT=1,NPTPTS)
226    FORMAT (F12.3,9E12.6)
74     CONTINUE
8Ø     CONTINUE
       V1=V1+VBLOCK
       IF(IFILE.EQ.NFILES) V1=VVTOP
       IF(V1.GE.V2) STOP 23
       VTOP=V1 + VBLOCK
  365 CONTINUE
       GO TO 5
C
       END
       FUNCTION FORM(Z,M)
C
C       FORM FACTOR FOR SUB-LORENTZIAN TAILS
C
       FORM = 1.Ø
       IF (M.NE.2) RETURN
       IF (Z.LT.Ø.5) RETURN
       IF (Z.GT.23.) GO TO 1Ø
       FORM=1.Ø69*EXP(-.133*Z)
```

```
      RETURN
10    FORM = .05
      IF (Z.LE.50.) RETURN
      FORM = 0.0
      IF (Z.GE.250.) RETURN
      FORM=.005*(12.5-.05*Z)
      RETURN
      END
      SUBROUTINE ABSORB(AL,AD,ETA,ARAT,Z,AK)
      IF ((ETA.LE.5.).AND.(ARAT.LE.2.)) GO TO 10
      AK=(.31831)*AL/(Z**2 + AL*AL)
      GO TO 20
10    CONTINUE
      AK=0.0
      DO 15 K=1,51
      Y=-2. + (K-1)*.1
      FY=(ARAT/AD)*.14952*EXP(-Y*Y)/(ARAT**2 + (ETA-Y)**2)
      FY=FY*.1
      AK=AK + FY
15    CONTINUE
20    RETURN
      END
      SUBROUTINE DATIN
      COMMON/INPUT/ P(10),T(10),W(7),V1,V2,DV,VLWST,VHGHST,DELTV
     K,BOUND,NPTPTS,MSPEC(7),SSTR,VBLOCK,DV2
C*CDC READ(5,76) NPTPTS,MSPEC
      READ(5,76,END=345) NPTPTS,MSPEC
   76 FORMAT(8I2)
C*CDC READ(5,77) (P(I),I=1,NPTPTS)
      READ(5,77,END=345) (P(I),I=1,NPTPTS)
   77 FORMAT(8(E10.0))
      READ(5,77,END=345) (T(I),I=1,NPTPTS)
C*CDC READ(5,77) (T(I),I=1,NPTPTS)
      WRITE(6,82) (P(I),I=1,NPTPTS)
   82 FORMAT(* PRESSURE=*,5(2X,F7.2)/10X,5(2X,F7.2))
      WRITE(6,84) (T(I),I=1,NPTPTS)
   84 FORMAT(* TEMPERATURE=*,5(2X,F7.2)/13X,5(2X,F7.2))
C*CDC IF(EOF(5).NE.0) GO TO 345
      READ(5,81) (W(M),M=1,7)
   81 FORMAT(7E10.3)
      WRITE(6,83)
   83 FORMAT(3X,*WATER*,6X,*CO2*,6X,*OZONE*,7X,*N2O*,7X,*CO*,8X,*CH4*,
     17X,*O2*,4X)
      WRITE(6,81)  (W(M),M=1,7)
      READ(5,85) V1,V2,DV,VLWST,VHGHST,DELTV,BOUND
85    FORMAT (7E10.3)
      WRITE(6,87) V1,V2,DV,VLWST,VHGHST,DELTV,BOUND
87    FORMAT (* (V1,V2,DV) =*,3F10.3,5X,* (VLWST,VHGHST,DELTV) =*,
     K3F10.3,5X,*BOUND =*,F10.3)
      READ(5,889) SSTR,VBLOCK,DV2
889   FORMAT (E10.2,F10.3,3F10.2)
      WRITE(6,89) SSTR,VBLOCK,DV2
89    FORMAT (*  SMIN FOR STRONG = *,E10.3,5X,*VBLOCK =*,F10.1,5X,
     &*DV2 =*,F5.2)
      IF (V1.GE.V2) STOP 21
      RETURN
```

```
345   STOP 20
      END
      SUBROUTINE STRONG (MSPEC,V1,V2,DV,DV2,JCALC,SSTR,MAX,NREC)
C  DETERMINES CLACULATIONAL POINTS FOR STRONG LINES
      LOGICAL LCHK,LCHK0
      DIMENSION G0(201),S0(201),LCHK0(201),DENS(7),MSPEC(7)
      DIMENSION JCALC(7),SPECIE(7),M0(201),A0(201)
      COMMON/LINES/ GNU(250),S(250),ALPHA(250),EDP(250),MOL(250),
     KLCHK(250),TI(250,9),ITI(250),TMAX
      COMMON/OMG/ OMEGA(201,6),STOR(6,9,304)
      DATA DENS/1.0,1.0,.01,.001,.0005,.005,.001/
      DATA SPECIE/4HH2O ,4HCO2 ,4HO3  ,4HN2O ,4HCO  ,4HCH4 ,4HO2  /
C***  INITIALIZE CONTROL VARIABLES
      W10 = SQRT(10.0)
      NMAX = 200
C**  TOO MANY LINES----INCREASE SMIN AND READ TAPE AGAIN
5     NLINES=0
      REWIND 11
      DO 30 IREC=1,NREC
      READ(11)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I),I=1,N)
      IF(GNU(N).LT.V1) GO TO 30
C**  THROW OUT LINES THAT ARE WEAKER THAN SSTR
      DO 20 J=1,N
      IF(GNU(J).LT.V1) GO TO 20
      IF(GNU(J).GT.V2) GO TO 27
      IF (S(J).LT.SSTR .AND. (.NOT.LCHK(J))) GO TO 20
      NLINES = NLINES+1
      IF(NLINES.LE.NMAX) GO TO 15
      SSTR=W10*SSTR
      GO TO 5
   15 G0(NLINES)=GNU(J)
      S0(NLINES)=S(J)
      A0(NLINES)=ALPHA(J)
      M0(NLINES)=MOL(J)
      LCHK0(NLINES)=LCHK(J)
20    CONTINUE
   30 CONTINUE
C ***  SET UP PARAMETERS
   27 ID0=5
      DELT1 = ID0*DV
      ISPACE = 2*ID0 + 2
      LMAX=2000
      LMAX1=LMAX - ISPACE - 5
      LMIN= LMAX/2
C ***  PICK OUT STRONG LINES
      FAC=1.0E-20
      JLOOP=0
  309 JLOOP=JLOOP+1
      JPTS=0
      FAC=.3*FAC
      DO 370 M=1,MAX
      JMAX = LMAX-JPTS
      JCALC(M)=0
      IF (MSPEC(M).LE.0) GO TO 370
      OMEGA(1,M)=V1
```

```
      MM=MSPEC(M)
      SMIN=FAC*DENS(MM)
      JCNT=1
      DO 32Ø JC=1,NLINES
      IF(MØ(JC).NE.MM) GO TO 32Ø
C***  GNU.GT. 2388 --- ACCEPT ALL CO2 R BRANCH FUNDAMENTAL LINES
      IF (GØ(JC).GT.2388..AND.LCHKØ(JC))GO TO 3Ø8
      IF(SØ(JC).LT.SMIN) GO TO 32Ø
C*** ACCEPT LINE - DETERMINE CALCULATIONAL POINTS
  3Ø8 D1=(GØ(JC)-OMEGA(JCNT,M))/DV
      IF (D1.LT.(.5*DV)) GO TO 32Ø
      ID=IDØ
      IF (D1.GE.ISPACE) GO TO 313
      ID=(D1+Ø.5)
C*** ID IS NUMBER OF POINTS ON LINE WING---DV=SPACING BTWN PTS
      IF (ID.EQ.Ø) ID=1
      D2=(GØ(JC)-OMEGA(JCNT,M))/ID
      JCNT=JCNT+ID
      OMEGA(JCNT,M)=GØ(JC)
C***  IF (JCNT.GT.1ØØ) JLOOP=6Ø
      IF (ID.EQ.1) GO TO 32Ø
      ID=ID-1
      GO TO 316
C*** ID.GE.8---LINES WELL SEPARATED - L.H.S OF INTERVAL
  313 DO 314 II=1,ID
      JCNTII=JCNT+II
  314 OMEGA(JCNTII,M)=OMEGA(JCNT,M)+II*DV
C*** DETERMINE POINTS BETWEEN THE TWO LINES---INCREMENTS OF DV2
      JCNTID=JCNT+ID
      VA = DV2*(FLOAT(INT(OMEGA(JCNTID,M)/DV2)) + 1.Ø )
      VB = DV2*FLOAT(INT((GØ(JC)-DELT1-.ØØ1)/DV2))
      JCNT = JCNT+2*ID+1
      IF (VB.LT.VA) GO TO 316
      ID2 = 1+INT((VB-VA)/DV2+.ØØØ5)
      JCNT = JCNT-ID-1
      DO 315 II=1,ID2
      JCNTII=JCNT+II
315   OMEGA(JCNTII,M) = VA+(II-1)*DV2
      JCNT = JCNT+ID+ID2+1
316   OMEGA(JCNT,M)=GØ(JC)
C*** LINES CLOSE --- OR --- R.H.S. OF INTERVAL
      DO 317 II=1,ID
      JCNTII=JCNT-II
  317 OMEGA(JCNTII,M)=OMEGA(JCNT,M)-II*DV
C***        IF TOO MANY CALC.PTS., INCREASE SMIN
      IF (JCNT .GT. JMAX) GO TO 371
  32Ø CONTINUE
C*** JCALC = NO,. OF CALCULATIONAL POINTS
      JCALC(M)=JCNT
  37Ø JPTS=JPTS+JCALC(M)
C***      DECIDE WHETHER TO LOOP BACK AGAIN
      IF (JLOOP.GE.6Ø) GO TO 371
      IF ((JPTS.LT.LMIN).AND.(FAC.GE.SSTR)) GO TO 3Ø9
      IF (JPTS.LT.LMAX1) GO TO 321
  371 FAC=4.*FAC
      GO TO 3Ø9
```

```
C
C
  321 CONTINUE
      ICOUNT=Ø
      DO 24Ø M=1,MAX
      MM=MSPEC(M)
      IF (MM.LE.Ø) GO TO 24Ø
      JCNT=JCALC(M)
      IF(JCNT.GT.1) GO TO 33Ø
C
C
C     NO STRONG LINES IN THIS BLOCK
C
      JCALC(M)=5
      JCNT = 5
      DLT = .25*(V2-V1)
      DO 331 K=2,5
  331 OMEGA(K,M)=V1+(K-1)*DLT
      WRITE(6,339) JLOOP,FAC,SPECIE(MM),(OMEGA(JJ,M),JJ=1,JCNT)
339   FORMAT(/* NO INTENSE LINES*,1ØX,*JLOOP =*,I4,
     &1ØX,*SMIN=*,E1Ø.3,12X,*SPECIES\*,A1Ø/
     &* OMEGA=*,5F14.3)
      GO TO 24Ø
C
C     STRONG LINES IN THIS BLOCK
C*** DEFINE CALCULATIONAL POINTS NEAR V2
  33Ø D1=(V2-OMEGA(JCNT,M))/DV
C**  LAST LINE VERY CLOSE TO V2????
      IF (D1.GT.1.Ø) GO TO 341
      JCNT = JCNT+1
      OMEGA(JCNT,M) = V2
      GO TO 335
341   ID=IDØ
      IF (D1.GE.ISPACE) GO TO 343
      ID=(D1+Ø.5)
      IF (ID.EQ.Ø) ID=1
      D2=(V2-OMEGA(JCNT,M))/ID
      JCNT=JCNT+ID
      OMEGA(JCNT,M)=V2
      IF (ID.EQ.1) GO TO 335
      ID=ID-1
      GO TO 346
  343 DO 344 II=1,ID
      JCNTII=JCNT+II
  344 OMEGA(JCNTII,M)=OMEGA(JCNT,M)+II*DV
      JCNTID=JCNT+ID+1
      OMEGA(JCNTID,M)=(OMEGA(JCNT,M)+V2)/2.
      JCNT=JCNT+2*(ID+1)
      OMEGA(JCNT,M)=V2
  346 DO 347 II=1,ID
      JCNTII=JCNT-II
  347 OMEGA(JCNTII,M)=OMEGA(JCNT,M)-II*DV
C*** PRINT STRONG LIVES AND CALC.PTS.
335   JCALC(M)=JCNT
      WRITE(6,325) JLOOP,JCNT,FAC,SPECIE(MM)
325   FORMAT (/*  MOST INTESE LINES:*,1ØX,*JLOOP =*,I3,5X,
```

```
     *I5,*  CALCULATIONAL POINTS*,5X,
     **SMIN=*,E1Ø.3,1ØX,A1Ø/5X,*V*,1ØX,*S*,6X,*ALPHA*,3X,*M*,1ØX,
     **INTERMEDIATE POINTS*)
      JCMIN=1
      JMAX1=JCNT-1
      J2 = ISPACE-1
      WRITE(6,327) (OMEGA(J,M),J=1,ISPACE)
327   FORMAT (F1Ø.3,26X,11F9.3,(/35X,1ØF9.3))
      DO 36Ø JJ=2,JMAX1
      DO 328 JC=JCMIN,NLINES
      IF (OMEGA(JJ,M).NE.GØ(JC)) GO TO 328
      J1=JJ+J2-1
      WRITE(6,326) GØ(JC),SØ(JC),AØ(JC),MØ(JC),(OMEGA(J+1,M),J=JJ,J1)
      JCMIN = JC
      GO TO 329
328   CONTINUE
  329 CONTINUE
36Ø   CONTINUE
326   FORMAT (F1Ø.3,2E9.2,I3,5X,11F9.3,(/35X,1ØF9.3))
24Ø   CONTINUE
      RETURN
      END
      SUBROUTINE REDLIN(V1,V2)
      DIMENSION CS1(9),CS2(7,9),CA(9),SUM1(6,9,1Ø1),SUM2(6,9,1Ø1)
      DIMENSION OMEGB(1Ø1)
      DIMENSION TI(25Ø,9),ITI(25Ø)
      DIMENSION GNU(25Ø),S(25Ø),ALPHA(25Ø),MOL(25Ø),LCHK(25Ø)
      DIMENSION EDP(25Ø),DENS(7),CO2R(5),MSPEC(7),ALPHB(6)
      COMMON/LINES/GNU,S,ALPHA,EDP,MOL,LCHK,TI,ITI,TMAX
      COMMON/INPUT/P(1Ø),T(1Ø),W(7),VA,VB,DV,VLWST,VHGHST,DELTV,
     X BOUND,NPTPTS,MSPEC,SSTR,VBLOCK,DV2
      COMMON/BLOCK1/MAX,CS1,CS2,CA,SUM1,SUM2,OMEGB,JMAX,NFILES
      LOGICAL IOEND,IOND13,LCHK
      DATA DENS/1.Ø,1.Ø,Ø.Ø1,Ø.ØØ1,Ø.ØØØ5,Ø.ØØ5,Ø.ØØ1/
      DATA CO2R/6H   Ø Ø,6H Ø 1 1,6H      ,6HØ Ø Ø ,6HØ 1   /
      DATA ALPHB/Ø.Ø7,Ø.11,Ø.Ø8,Ø.Ø6,Ø.Ø55,Ø.Ø48/
      IFILE=Ø
      IOEND=.FALSE.
      IOND13=.FALSE.
      REWIND 11
      END FILE 11
      IN=11
      IOUT=12
      REWIND 2
      REWIND IN
      REWIND IOUT
      REWIND 13
      VLOW=V1-BOUND
      VHIGH=V2+BOUND
      VL=V1-VBLOCK
  1ØØ VL=VL+VBLOCK
      IF(VL.GE.V2) GO TO 23Ø
      VR=VL+VBLOCK
      IF(VR.GT.V2) VR=V2
      VBOT=VL-BOUND
      VTOP=VR+BOUND
```

```
      VRB=VR-BOUND
      I=1
  125 IF(I.LE.25Ø) GO TO 13Ø
      N=25Ø
      WRITE(6,999) VL,VR,VBOT,VTOP,VRB,VLWST,VHGHST,VSTEP,VLOW,VHIGH
  999 FORMAT(1X,1ØF1Ø.3)
      WRITE(13)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),LCHK(I),I=1,N)
      I=1
13Ø   CONTINUE
C*CDC READ(IN)GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),LCHK(I)
      READ(IN,END=21Ø)GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),LCHK(I)
C*CDC IF(EOF(IN)) 21Ø,15Ø
  15Ø V=GNU(I)
      IF(VR.GE.V2) GO TO 16Ø
      IF(V.GE.VRB)WRITE(IOUT)GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I)
  16Ø IF(V.LE.VTOP) GO TO 2ØØ
      IF(IOEND) GO TO 13Ø
      N=I-1
      WRITE(6,999) VL,VR,VBOT,VTOP,VRB,VLWST,VHGHST,VSTEP,VLOW,VHIGH
      IF(N.GT.Ø)WRITE(13)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I),I=1,N)
      END FILE 13
      IFILE=IFILE+1
      IOEND=.TRUE.
      GO TO 13Ø
  2ØØ I=I+1
      GO TO 125
  21Ø IF(IOEND) GO TO 22Ø
      IF(.NOT.IOND13) GO TO 23Ø
  215 IF(VR.LT.V2) GO TO 23Ø
      N=I-1
      WRITE(6,999) VL,VR,VBOT,VTOP,VRB,VLWST,VHGHST,VSTEP,VLOW,VHIGH
      IF(N.GT.Ø)WRITE(13)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I),I=1,N)
      END FILE 13
      IFILE=IFILE+1
      GO TO 23Ø
  22Ø END FILE IOUT
      ISAVE=IOUT
      IOUT=IN
      IN=ISAVE
      REWIND IN
      REWIND IOUT
      IOEND=.FALSE.
      GO TO 1ØØ
23Ø   CONTINUE
C*CDC READ(2) TMIN,TMAX,NREC,((TI(I1,J1),J1=1,9),DUM,
      READ(2,END=28Ø,ERR=24Ø) TMIN,TMAX,NREC,((TI(I1,J1),J1=1,9),DUM,
     X DUM,DUM,ITI(I1),I1=1,NREC)
C*CDC JTO=IOCHEC(2)
C*CDC IF(JTO) 24Ø,27Ø
27Ø   CONTINUE
C*CDC IF(EOF(2)) 28Ø,29Ø
      GO TO 29Ø
  24Ø WRITE(6,245) GNU(I)
```

```
245 FORMAT(* PARITY ERROR ENCOUNTERED AT*,F12.3)
    GO TO 230
280 IEOF=IEOF+1
    NEOF=NEOF+1
    IF(NEOF.GT.2) STOP 22
    GO TO 230
290 NEOF=0
    IF(TMAX.LT.VLWST) GO TO 230
    IF(TMIN.GT.VHGHST) GO TO 1500
    DO 1100 K=1,NREC
    DO 310 MM=1,MAX
    IF(ITI(K).EQ.MSPEC(MM)) GO TO 320
310 CONTINUE
    GO TO 1100
320 V=TI(K,1)
    IF(V.GT.VHGHST) GO TO 1110
    IF(V.LT.VLWST) GO TO 1100
    M=ITI(K)
    SMIN=TI(K,2)*DENS(M)
    IF(SMIN.LE.1.0E-27) GO TO 1100
    IF(I.LE.250) GO TO 380
    IF(IOEND) GO TO 380
    N=250
    WRITE(6,999) VL,VR,VBOT,VTOP,VRB,VLWST,VHGHST,VSTEP,VLOW,VHIGH
    WRITE(13)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),LCHK(I),
   X I=1,N)
    I=1
380 GNU(I)=V
    S(I)=TI(K,2)
    ALPHA(I)=TI(K,3)
    IF(M.EQ.1) GO TO 390
    IF(ALPHA(I).GT.0.0) GO TO 385
    ALPHA(I)=ALPHB(M-1)
    GO TO 390
385 IF(ALPHA(I).LT.0.01.OR.ALPHA(I).GT.1.0) ALPHA(I)=0.06
390 EDP(I)=TI(K,4)
    MOL(I)=M
    IF(M.NE.2) GO TO 1000
    LCHK(I)=.FALSE.
    DO 400 J=1,5
    IF(CO2R(J).NE.TI(K,J+4)) GO TO 1000
400 CONTINUE
    LCHK(I)=.TRUE.
1000 IF(V.LT.VLOW) GO TO 1055
    IF(IOND13) GO TO 1055
    IF(VR.GE.V2) GO TO 1020
    IF(V.GT.VHIGH) GO TO 1020
    IF(V.GE.VRB) WRITE(IOUT)GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
   X LCHK(I)
1020 IF(V.LE.VTOP) GO TO 1050
    IF(V.GT.VHIGH) IOND13=.TRUE.
    IF(IOEND) GO TO 1055
    WRITE(6,999) VL,VR,VBOT,VTOP,VRB,VLWST,VHGHST,VSTEP,VLOW,VHIGH
    N=I-1
    IF(N.GT.0) WRITE(13)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
   X LCHK(I),I=1,N)
```

```
      END FILE 13
      IFILE=IFILE+1
      IOEND=.TRUE.
      GO TO 1055
 1050 L=I
      I=I+1
      GO TO 1057
 1055 L=I
 1057 DO 1080 NPT=1,NPTPTS
      SO=S(L)*CS2(M,NPT)*EXP(-EDP(L)*CS1(NPT))
      AL=ALPHA(L)*CA(NPT)
      DO 1070 J=1,JMAX
      VV=OMEGB(J)
      Z1=ABS(VV-V)
      IF(Z1.LT.BOUND) GO TO 1070
      Z2=ABS(VV+DELTV-V)
      IF(Z2.LT.BOUND) GO TO 1070
      FRM1=1.0
      FRM2=1.0
      IF(M.NE.2) GO TO 1060
      FRM1=FORM(Z1,M)
      FRM2=FORM(Z2,M)
 1060 CONTINUE
      SUM1(MM,NPT,J)=SUM1(MM,NPT,J)+FRM1*.3183*SO*AL/(Z1**2+AL**2)
      SUM2(MM,NPT,J)=SUM2(MM,NPT,J)+FRM2*.3183*SO*AL/(Z2**2+AL**2)
 1070 CONTINUE
 1080 CONTINUE
 1100 CONTINUE
 1110 IF(.NOT.IOEND) GO TO 230
 1125 END FILE IOUT
      ISAVE=IOUT
      IOUT=IN
      IN=ISAVE
      IOEND=.FALSE.
      REWIND IN
      REWIND IOUT
      GO TO 100
 1500 NFILES=IFILE
      RETURN
      END
```

AD-A064 019 AERODYNE RESEARCH INC BEDFORD MASS F/G 9/2
A USER'S GUIDE TO MIDTRAN - A COMBINATION OF LOWTRAN AND HITRAN--ETC(U)
JUN 78 D ROBERTSON, R SPECHT F19628-77-C-0198
UNCLASSIFIED ARI-RR-124 AFGL-TR-78-0184 NL

2 OF 2
AD
A064 019

END
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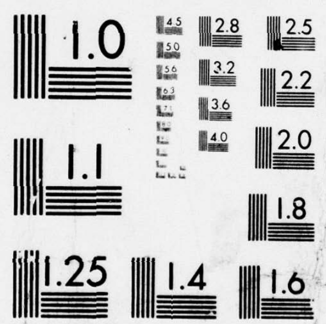

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

APPENDIX C

SAMPLE CASE

INPUT FILE

```
  6  1  2
         1          .9       3ØØ.   -1    Ø    Ø    Ø        1.        1.
         Ø.         2.        1Ø.
     19Ø5.       1915.        .Ø1
 -1
MIDTRAN TEST - TRANSMITTANCE
        .2          .1          3
       -1.          Ø.         1.
        Ø.          1.         Ø.
MIDTRAN TEST - RADIATION
```

OUTPUT FILE

```
EMISSIVITY=Ø.9ØØ          T(BACKGROUND)=     3ØØ.ØDEGREES K
          Ø.ØØØ      2.ØØØ     1Ø.ØØØ      Ø.ØØØ     Ø.ØØØ     Ø.ØØØ
        H1=  Ø.ØØØKM,H2=  2.ØØØKM,ANGLE= 1Ø.ØØØØGEOM. RANGE =   2.Ø3KM,BETA= Ø.ØØ317,VIS=   Ø.Ø

        SLANT PATH BETWEEN ALTITUDES H1 AND H2 WHERE H1  =  Ø.ØØØ KM H2 =  2.ØØØ KM,ZENITH ANGLE = 1Ø.ØØØ DEGREES

                  MODEL ATMOSPHERE 6 = 1962 US STANDARD

                        HAZE MODEL 1 = 23KM VISUAL RANGE

        FREQUENCY RANGE V1=  19Ø5.Ø CM-1 TO V2=  1915.Ø CM-1 FOR DV =   5.Ø CM-1   (  5.22 -  5.25 MICRONS )
```

HORIZONTAL PROFILES

1	0.0	0.737E-02	0.929E 00	0.252E-07	0.739E 00	0.540E-02	0.948E 00	0.100E 01	0.252E-07	0.260E-03	0.848E-01	0.272E-03
2	1.0	0.525E-02	0.778E 00	0.252E-07	0.601E 00	0.309E-02	0.860E 00	0.440E 00	0.252E-07	0.235E-03	0.590E-01	0.247E-03
3	2.0	0.362E-02	0.648E 00	0.252E-07	0.487E 00	0.167E-02	0.779E 00	0.190E 00	0.252E-07	0.213E-03	0.399E-01	0.224E-03
4	3.0	0.225E-02	0.537E 00	0.233E-07	0.393E 00	0.736E-03	0.704E 00	0.798E-01	0.233E-07	0.192E-03	0.243E-01	0.202E-03
5	4.0	0.137E-02	0.444E 00	0.215E-07	0.315E 00	0.317E-03	0.634E 00	0.422E-01	0.215E-07	0.173E-03	0.147E-01	0.182E-03
6	5.0	0.800E-03	0.365E 00	0.215E-07	0.251E 00	0.125E-03	0.570E 00	0.318E-01	0.215E-07	0.155E-03	0.849E-02	0.164E-03
7	6.0	0.475E-03	0.298E 00	0.210E-07	0.199E 00	0.514E-04	0.511E 00	0.224E-01	0.210E-07	0.139E-03	0.504E-02	0.147E-03
8	7.0	0.262E-03	0.243E 00	0.229E-07	0.157E 00	0.186E-04	0.457E 00	0.208E-01	0.229E-07	0.124E-03	0.280E-02	0.131E-03
9	8.0	0.150E-03	0.196E 00	0.243E-07	0.123E 00	0.723E-05	0.407E 00	0.215E-01	0.243E-07	0.110E-03	0.161E-02	0.117E-03
10	9.0	0.575E-04	0.158E 00	0.332E-07	0.959E-01	0.128E-05	0.362E 00	0.206E-01	0.332E-07	0.979E-04	0.627E-03	0.104E-03
11	10.0	0.225E-04	0.126E 00	0.420E-07	0.741E-01	0.240E-06	0.320E 00	0.201E-01	0.420E-07	0.866E-04	0.250E-03	0.920E-04
12	11.0	0.102E-04	0.100E 00	0.607E-07	0.568E-01	0.613E-07	0.282E 00	0.188E-01	0.607E-07	0.753E-04	0.117E-03	0.811E-04
13	12.0	0.462E-05	0.763E-01	0.747E-07	0.416E-01	0.126E-07	0.242E 00	0.197E-01	0.747E-07	0.643E-04	0.452E-04	0.694E-04
14	13.0	0.225E-05	0.579E-01	0.794E-07	0.303E-01	0.297E-08	0.206E 00	0.182E-01	0.794E-07	0.550E-04	0.188E-04	0.593E-04
15	14.0	0.105E-05	0.440E-01	0.887E-07	0.222E-01	0.647E-09	0.176E 00	0.179E-01	0.887E-07	0.470E-04	0.750E-05	0.507E-04
16	15.0	0.900E-06	0.334E-01	0.981E-07	0.162E-01	0.476E-09	0.151E 00	0.168E-01	0.981E-07	0.402E-04	0.550E-05	0.433E-04
17	16.0	0.762E-06	0.254E-01	0.112E-06	0.118E-01	0.341E-09	0.129E 00	0.160E-01	0.112E-06	0.343E-04	0.398E-05	0.370E-04
18	17.0	0.650E-06	0.193E-01	0.131E-06	0.865E-02	0.248E-09	0.110E 00	0.158E-01	0.131E-06	0.294E-04	0.290E-05	0.317E-04
19	18.0	0.550E-06	0.147E-01	0.149E-06	0.632E-02	0.178E-09	0.942E-01	0.153E-01	0.149E-06	0.251E-04	0.210E-05	0.271E-04
20	19.0	0.550E-06	0.112E-01	0.163E-06	0.462E-02	0.178E-09	0.805E-01	0.128E-01	0.163E-06	0.215E-04	0.179E-05	0.231E-04
21	20.0	0.550E-06	0.848E-02	0.177E-06	0.338E-02	0.178E-09	0.688E-01	0.943E-02	0.177E-06	0.183E-04	0.153E-05	0.198E-04
22	21.0	0.600E-06	0.641E-02	0.177E-06	0.245E-02	0.204E-09	0.586E-01	0.684E-02	0.177E-06	0.156E-04	0.139E-05	0.168E-04
23	22.0	0.650E-06	0.485E-02	0.182E-06	0.178E-02	0.232E-09	0.499E-01	0.514E-02	0.182E-06	0.133E-04	0.125E-05	0.143E-04
24	23.0	0.712E-06	0.368E-02	0.177E-06	0.130E-02	0.270E-09	0.426E-01	0.394E-02	0.177E-06	0.113E-04	0.114E-05	0.122E-04
25	24.0	0.762E-06	0.279E-02	0.168E-06	0.949E-03	0.299E-09	0.363E-01	0.312E-02	0.168E-06	0.967E-05	0.102E-05	0.104E-04
26	25.0	0.825E-06	0.212E-02	0.159E-06	0.693E-03	0.339E-09	0.310E-01	0.263E-02	0.159E-06	0.650E-05	0.921E-06	0.891E-05
27	30.0	0.475E-06	0.548E-03	0.934E-07	0.148E-03	0.96[illegible]E-10	0.143E-01	0.7[illegible]1E-03	0.934E-07	0.299E-05	0.213E-06	0.409E-05
28	35.0	0.200E-06	0.143E-03	0.514E-07	0.319E-04	0.127E-10	0.655E-02	0.208E-03	0.514E-07	0.138E-05	0.343E-07	0.188E-05
29	40.0	0.837E-07	0.386E-04	0.229E-07	0.719E-05	0.144E-11	0.306E-02	0.548E-04	0.229E-07	0.658E-06	0.491E-08	0.878E-06
30	45.0	0.400E-07	0.116E-04	0.794E-08	0.182E-05	0.256E-12	0.152E-02	0.144E-04	0.794E-08	0.333E-06	0.979E-09	0.437E-06
31	50.0	0.150E-07	0.375E-05	0.187E-08	0.503E-06	0.314E-13	0.795E-03	0.381E-05	0.187E-08	0.124E-06	0.174E-09	0.228E-06
32	70.0	0.187E-09	0.466E-07	0.402E-10	0.329E-08	0.186E-16	0.677E-04	0.196E-07	0.402E-10	0.979E-08	0.478E-12	0.195E-07
33	100.0	0.125E-11	0.542E-11	0.201E-13	0.105E-12	0.115E-20	0.386E-06	0.696E-11	0.201E-13	0.555E-10	0.231E-16	0.111E-09
34	$99999	0.000E 00	0.000E 00	0.000E 00	0.000E 00	0.090E 00	0.000E 00	0.000E 00	0.000E 00	0.000E 00	0.000E 00	0.000E 00

```
      VERTICAL PROFILES                                                                                    PSI        PHI       BETA      THETA     RA
1    Ø.Ø Ø.635E-Ø2 Ø.864E ØØ Ø.256E-Ø7 Ø.678E ØØ Ø.42ØE-Ø2 Ø.917E ØØ Ø.692E ØØ Ø.256E-Ø7  -Ø.ØØØØ  17Ø.ØØ16   Ø.ØØ16   1Ø.ØØØØ
2    1.Ø Ø.1Ø8E-Ø1 Ø.159E Ø1 Ø.512E-Ø7 Ø.123E Ø1 Ø.655E-Ø2 Ø.175E Ø1 Ø.995E ØØ Ø.512E-Ø7   Ø.ØØØ2  17Ø.ØØ29   Ø.ØØ32    9.9986
 Ø.ØØØ

     EQUIVALENT SEA LEVEL ABSORBER AMOUNTS

               WATER VAPOUR    .CO2 ETC.       OZONE    NITROGEN (CONT)  H2O (CONT)    MOL  SCAT      AEROSOL      OZONE(U-V)
                                                              KM          GM CM-2         KM            KM           ATM CM

     W(1-8)=                                                 Ø.123E Ø1   Ø.655E-Ø2    Ø.175E Ø1    Ø.995E ØØ    Ø.512E-Ø7
                                                                         Ø.122E ØØ

               FREQ WAVELENGTH  TOTAL     H2O,      CO2+      OZONE   N2 CONT  H2O CONT MOL SCAT  AEROSOL  AEROSOL   INTEGRATED
               CM-1  MICRONS    TRANS     TRANS     TRANS     TRANS    TRANS    TRANS    TRANS     TRANS     ABS     ABSORPTION
               19Ø5   5.2493   Ø.9858    1.ØØØØ    1.ØØØØ    1.ØØØØ   1.ØØØØ   1.ØØØØ   1.ØØØØ    Ø.9858   Ø.ØØ28      Ø.Ø4
               191Ø   5.2356   Ø.9858    1.ØØØØ    1.ØØØØ    1.ØØØØ   1.ØØØØ   1.ØØØØ   1.ØØØØ    Ø.9858   Ø.ØØ28      Ø.12
               1915   5.2219   Ø.9857    1.ØØØØ    1.ØØØØ    1.ØØØØ   1.ØØØØ   1.ØØØØ   1.ØØØØ    Ø.9857   Ø.ØØ28      Ø.17

    LL   LEVEL  ALTITUDE    TEMP       PRES        WH2O        WO3          WGAS
     1     1      Ø.ØØ     284.83     954.Ø9    Ø.692E-Ø2   Ø.279E-Ø7   Ø.917E ØØ
     2     2      1.ØØ     278.33     845.21    Ø.536E-Ø2   Ø.3Ø8E-Ø7   Ø.832E ØØ
    INTEGRATED ASORPTION FROM 19Ø5 TO 1915 CM-1 =      Ø.19,AVERAGE TRANSMITTANCE =Ø.9814

    MEDIUM  RESOLUTION   DVM=Ø.Ø1Ø WAVENUMBERS
```

VARIABLE SLIT FUNCTION
WIDTH= 0.20000 SHIFT= 0.10000 NO. OF DEFINING PTS= 3
YS ARE 0.000 1.000 0.000
XS ARE -1.000 0.000 1.000

ATMOSPHERIC TRANSMITTANCE

LAMBDA MICRONS	V CM-1	TRANSMITTANCE		LAMBDA MICRONS	V CM-1	TRANSMITTANCE		LAMBDA MICRONS	V CM-1	TRANSMITTANCE	
5.2490	1905.11	0.01	0.00960	5.2400	1908.41	0.00	0.00000	5.2309	1911.71	0.07	0.0673
5.2488	1905.21	0.03	0.02728	5.2397	1908.51	0.00	0.00003	5.2306	1911.81	0.06	0.0580
5.2485	1905.31	0.07	0.07438	5.2394	1908.61	0.00	0.00022	5.2304	1911.91	0.07	0.0708
5.2482	1905.41	0.15	0.15220	5.2391	1908.71	0.00	0.00064	5.2301	1912.01	0.12	0.1224
5.2479	1905.51	0.17	0.17165	5.2389	1908.81	0.00	0.00113	5.2298	1912.11	0.15	0.1534
5.2477	1905.61	0.18	0.17516	5.2386	1908.91	0.00	0.00132	5.2296	1912.21	0.16	0.1604
5.2474	1905.71	0.18	0.17833	5.2383	1909.01	0.00	0.00103	5.2293	1912.31	0.15	0.1537
5.2471	1905.81	0.18	0.18142	5.2380	1909.11	0.00	0.00049	5.2290	1912.41	0.13	0.1250
5.2468	1905.91	0.18	0.18360	5.2378	1909.21	0.00	0.00015	5.2287	1912.51	0.09	0.0886
5.2466	1906.01	0.17	0.17129	5.2375	1909.31	0.00	0.00002	5.2285	1912.61	0.10	0.0986
5.2463	1906.11	0.15	0.15128	5.2372	1909.41	0.00	0.00000	5.2282	1912.71	0.12	0.1176
5.2460	1906.21	0.15	0.14787	5.2369	1909.51	0.00	0.00000	5.2279	1912.81	0.15	0.1494
5.2457	1906.31	0.14	0.14351	5.2367	1909.61	0.00	0.00000	5.2276	1912.91	0.18	0.1798
5.2455	1906.41	0.12	0.12349	5.2364	1909.71	0.00	0.00000	5.2274	1913.01	0.20	0.2009
5.2452	1906.51	0.10	0.09915	5.2361	1909.81	0.00	0.00000	5.2271	1913.11	0.21	0.2105
5.2449	1906.61	0.08	0.08162	5.2358	1909.91	0.00	0.00000	5.2268	1913.21	0.22	0.2151
5.2446	1906.71	0.07	0.06530	5.2356	1910.01	0.00	0.00000	5.2265	1913.31	0.21	0.2127
5.2444	1906.81	0.05	0.04873	5.2353	1910.11	0.00	0.00000	5.2263	1913.41	0.20	0.2033
5.2441	1906.91	0.03	0.03305	5.2350	1910.21	0.00	0.00000	5.2260	1913.51	0.19	0.1912
5.2438	1907.01	0.02	0.01941	5.2348	1910.31	0.00	0.00000	5.2257	1913.61	0.17	0.1735
5.2435	1907.11	0.01	0.00902	5.2345	1910.41	0.00	0.00000	5.2255	1913.71	0.14	0.1408
5.2433	1907.21	0.00	0.00306	5.2342	1910.51	0.00	0.00001	5.2252	1913.81	0.08	0.0770
5.2430	1907.31	0.00	0.00063	5.2339	1910.61	0.00	0.00016	5.2249	1913.91	0.03	0.0341
5.2427	1907.41	0.00	0.00006	5.2337	1910.71	0.00	0.00098	5.2246	1914.01	0.05	0.0466
5.2424	1907.51	0.00	0.00000	5.2334	1910.81	0.00	0.00347	5.2244	1914.11	0.10	0.0968
5.2422	1907.61	0.00	0.00000	5.2331	1910.91	0.01	0.00810	5.2241	1914.21	0.12	0.1233
5.2419	1907.71	0.00	0.00000	5.2328	1911.01	0.01	0.01412	5.2238	1914.31	0.12	0.1193
5.2416	1907.81	0.00	0.00000	5.2326	1911.11	0.02	0.01869	5.2235	1914.41	0.09	0.0853
5.2413	1907.91	0.00	0.00000	5.2323	1911.21	0.02	0.02453	5.2233	1914.51	0.03	0.0252
5.2411	1908.01	0.00	0.00000	5.2320	1911.31	0.03	0.03211	5.2230	1914.61	0.00	0.0017
5.2408	1908.11	0.00	0.00000	5.2317	1911.41	0.04	0.04174	5.2227	1914.71	0.03	0.0300
5.2405	1908.21	0.00	0.00000	5.2315	1911.51	0.05	0.05331	5.2225	1914.81	0.07	0.0733
5.2402	1908.31	0.00	0.00000	5.2312	1911.61	0.06	0.06425	5.2222	1914.91	0.09	0.0866

VARIABLE-SLIT FUNCTION
WIDTH= Ø.2ØØØØ SHIFT= Ø.1ØØØØ NO. OF DEFINING PTS= 3
YS ARE Ø.ØØØ 1.ØØØ Ø.ØØØ
XS ARE -1.ØØØ Ø.ØØØ 1.ØØØ

RADIATION(WATTS/SR/CM**2/UNITS)

V CM-1	RADIATION PER CM-1	LAMBDA MICRONS	RADIATION PER UM	V CM-1	RADIATION PER CM-1	LAMBDA MICRONS	RADIATION PER UM	V CM-1	RADIATION PER CM-1	LAMBDA MICRONS	RADIATION PER UM
19Ø5.11	4.5799E-Ø7	5.249Ø	1.662E-Ø4	19Ø8.41	4.3338E-Ø7	5.24ØØ	1.578E-Ø4	1911.71	4.8292E-Ø7	5.23Ø9	1.765E-Ø4
19Ø5.21	4.7135E-Ø7	5.2488	1.711E-Ø4	19Ø8.51	4.3464E-Ø7	5.2397	1.583E-Ø4	1911.81	4.7765E-Ø7	5.23Ø6	1.746E-Ø4
19Ø5.31	4.9598E-Ø7	5.2485	1.8Ø1E-Ø4	19Ø8.61	4.3683E-Ø7	5.2394	1.591E-Ø4	1911.91	4.83Ø1E-Ø7	5.23Ø4	1.766E-Ø4
19Ø5.41	5.29Ø8E-Ø7	5.2482	1.921E-Ø4	19Ø8.71	4.391ØE-Ø7	5.2391	1.6ØØE-Ø4	1912.Ø1	5.Ø567E-Ø7	5.23Ø1	1.849E-Ø4
19Ø5.51	5.3663E-Ø7	5.2479	1.948E-Ø4	19Ø8.81	4.4Ø7ØE-Ø7	5.2389	1.6Ø6E-Ø4	1912.11	5.1777E-Ø7	5.2298	1.893E-Ø4
19Ø5.61	5.3777E-Ø7	5.2477	1.953E-Ø4	19Ø8.91	4.411ØE-Ø7	5.2386	1.6Ø7E-Ø4	1912.21	5.2Ø22E-Ø7	5.2296	1.9Ø2E-Ø4
19Ø5.71	5.388ØE-Ø7	5.2474	1.957E-Ø4	19Ø9.Ø1	4.4ØØ5E-Ø7	5.2383	1.6Ø4E-Ø4	1912.31	5.1743E-Ø7	5.2293	1.892E-Ø4
19Ø5.81	5.398ØE-Ø7	5.2471	1.961E-Ø4	19Ø9.11	4.3771E-Ø7	5.238Ø	1.595E-Ø4	1912.41	5.Ø562E-Ø7	5.229Ø	1.849E-Ø4
19Ø5.91	5.4Ø44E-Ø7	5.2468	1.963E-Ø4	19Ø9.21	4.3525E-Ø7	5.2378	1.587E-Ø4	1912.51	4.89Ø5E-Ø7	5.2287	1.789E-Ø4
19Ø6.Ø1	5.3529E-Ø7	5.2466	1.945E-Ø4	19Ø9.31	4.3319E-Ø7	5.2375	1.579E-Ø4	1912.61	4.9252E-Ø7	5.2285	1.8Ø2E-Ø4
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19Ø6.31	5.2441E-Ø7	5.2457	1.9Ø6E-Ø4	19Ø9.61	4.31Ø2E-Ø7	5.2367	1.572E-Ø4	1912.91	5.2566E-Ø7	5.2276	1.924E-Ø4
19Ø6.41	5.16Ø8E-Ø7	5.2455	1.876E-Ø4	19Ø9.71	4.3Ø86E-Ø7	5.2364	1.571E-Ø4	1913.Ø1	5.3328E-Ø7	5.2274	1.952E-Ø4
19Ø6.51	5.Ø541E-Ø7	5.2452	1.837E-Ø4	19Ø9.81	4.3Ø71E-Ø7	5.2361	1.571E-Ø4	1913.11	5.3662E-Ø7	5.2271	1.964E-Ø4
19Ø6.61	4.9781E-Ø7	5.2449	1.81ØE-Ø4	19Ø9.91	4.3Ø55E-Ø7	5.2358	1.571E-Ø4	1913.21	5.3822E-Ø7	5.2268	1.97ØE-Ø4
19Ø6.71	4.9Ø25E-Ø7	5.2446	1.782E-Ø4	191Ø.Ø1	4.3Ø4ØE-Ø7	5.2356	1.57ØE-Ø4	1913.31	5.372ØE-Ø7	5.2265	1.967E-Ø4
19Ø6.81	4.8189E-Ø7	5.2444	1.752E-Ø4	191Ø.11	4.3Ø25E-Ø7	5.2353	1.57ØE-Ø4	1913.41	5.3362E-Ø7	5.2263	1.954E-Ø4
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19Ø7.21	4.4711E-Ø7	5.2433	1.626E-Ø4	191Ø.51	4.3Ø74E-Ø7	5.2342	1.572E-Ø4	1913.81	4.8223E-Ø7	5.2252	1.766E-Ø4
19Ø7.31	4.4Ø82E-Ø7	5.243Ø	1.6Ø4E-Ø4	191Ø.61	4.3298E-Ø7	5.2339	1.581E-Ø4	1913.91	4.5897E-Ø7	5.2249	1.681E-Ø4
19Ø7.41	4.3664E-Ø7	5.2427	1.589E-Ø4	191Ø.71	4.3686E-Ø7	5.2337	1.595E-Ø4	1914.Ø1	4.6646E-Ø7	5.2246	1.7Ø9E-Ø4
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19Ø7.81	4.3382E-Ø7	5.2416	1.579E-Ø4	1911.11	4.5663E-Ø7	5.2326	1.668E-Ø4	1914.41	4.8612E-Ø7	5.2235	1.782E-Ø4
19Ø7.91	4.3366E-Ø7	5.2413	1.579E-Ø4	1911.21	4.6Ø58E-Ø7	5.2323	1.682E-Ø4	1914.51	4.5154E-Ø7	5.2233	1.655E-Ø4
19Ø8.Ø1	4.3351E-Ø7	5.2411	1.578E-Ø4	1911.31	4.6518E-Ø7	5.232Ø	1.699E-Ø4	1914.61	4.2862E-Ø7	5.223Ø	1.571E-Ø4
19Ø8.11	4.3335E-Ø7	5.24Ø8	1.578E-Ø4	1911.41	4.7Ø56E-Ø7	5.2317	1.719E-Ø4	1914.71	4.564ØE-Ø7	5.2227	1.673E-Ø4
19Ø8.21	4.3319E-Ø7	5.24Ø5	1.577E-Ø4	1911.51	4.7649E-Ø7	5.2315	1.741E-Ø4	1914.81	4.8Ø39E-Ø7	5.2225	1.761E-Ø4
19Ø8.31	4.33Ø9E-Ø7	5.24Ø2	1.577E-Ø4	1911.61	4.8167E-Ø7	5.2312	1.76ØE-Ø4	1914.91	4.8616E-Ø7	5.2222	1.783E-Ø4

APPENDIX D

MIDTRAN FLOWCHART; SUBROUTINE LIST

Table D-1. Generalized MIDTRAN Flowchart

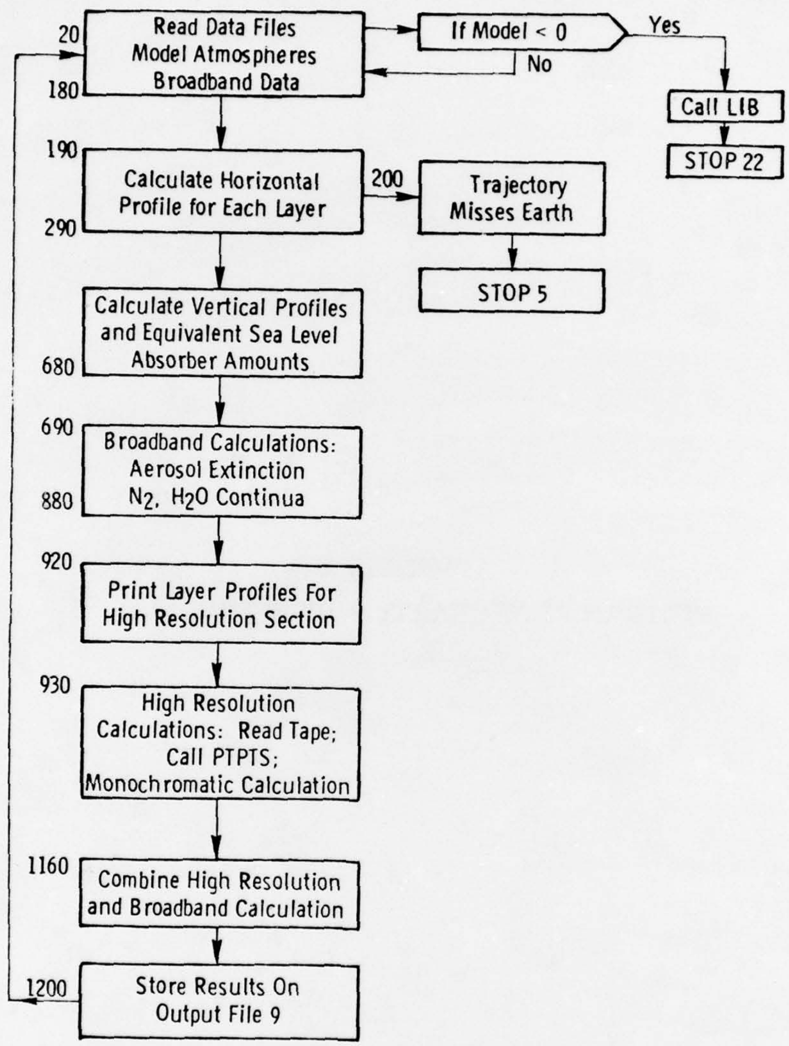

Table D-2. Listing of MIDTRAN Subroutines

Subroutine	Purpose
POINT	Computes the equivalent absorber amount at a given altitude (from LOWTRAN).
PTPTS	Determines the interpolation points from the data tape for each layer.
ANGL	Computes the zenith angle given H1, H2 and the earth center angle (from LOWTRAN).
LIB	Performs output functions Reads Cards 5, 6, 7.
CRAM	Removes trailing blanks in Card 5.
GEN	Degrades results to the desired resolution using the generalized slit function.
FRAME	Sets up frame for the plots
PROUT	Prints output and plots curves.
SPACE	Skips over data sets on File 9.

APPENDIX E
LIST OF MIDTRAN VARIABLES

A	Width of fixed triangular slit function (= 0.1 cm^{-1})
AHAZE	Aerosol number density for MODEL = 1
AHZ2	Aerosol number density for MODEL = 2
AK	Extinction coefficient read from tape for Kth pressure-temperature point at frequency VV
AKK	Interpolated extinction coefficient
AL	Equivalent absorber amount per km at level L
ALAM	Wavelength (μm)
ALT	Altitude at level Z (LYR)
ANGLE	Input zenith angle (degrees) (compare with θ_o in the text)
AVW	Average wavelength used in refractive index expression
AO	Constant A defined in Eq. (10) of LOWTRAN3 Manual
B	Blackbody function
BET	Angle subtended at the earth's center as path transverses adjacent levels
BETA	Total angle subtended by path at earth's center
CA	Conversion factor from degrees to radians
CO	Wavelength dependent coefficient used in refractive index expression
CON	Species concentrations
CW	Wavelength dependent coefficient used in refractive index expression
C4	Absorption coefficient for nitrogen (~ 4 μm)
C5	Absorption coefficient for water vapor continuum
C6	Extinction coefficient for molecular scattering
C7	Extinction coefficient for aerosol models
C7A	Aerosol absorption coefficient
D	Water vapor amount (pr.cm/km) at level L
DELV	Increment for fixed slit function
DIST	Optical depth of a species
DP	Dew point temperature (^{o}C)
DS	Path length from level L to Level L + 1
DV	Wavenumber increment

DVM	MRDA frequency interval
DZ	Height increment from level L to level L + 1
E	Equivalent absorber amounts per km at height H
EH	Equivalent absorber amounts
EMIS	Emissivity of background radiation source
ENDF	End-of-file control variable
EV	Integrated absorber amount from level L to level L + 1
FAC	Dummy variable
FAC2	Summing variable for transmittance
FAC5	Log transmittance for radiation
FAC6	Summing variable for transmittance
FNU	Frequency for print-out
FP	Intermediate result in interpolation of AK
FRAD	Degraded radiation
FREQT	Dummy frequency variable
FT	Intermediate result in interpolation of AK
H	Altitude
HAZE	Aerosol number density (no. cm^{-3})
HM	Estimated tangent height (km)
HMIN	Minimum altitude of path trajectory (km)
HZZ	Dummy variable for transmittance
HZ1	Aerosol number density (no. cm^{-3}) for 23 km visual range
HZ2	Aerosol number density (no. cm^{-3}) for 5 km visual range
H1	Initial altitude (km)
H2	Final altitude (km)
IC	Counting variable for low resolution calculations
ICNT	Index for low resolution calculations
ICOUNT	Index for low resolution printed output
IDV	Frequency increment
IFIND	Call parameter for subroutine ANGL

IHAZE	Aerosol model indicator
ILP	Integer variable for printing heading
IM	Parameter used when reading in a new atmospheric model
IP	Indicator for using subroutine POINT to calculate refractive index only (IP = 0) or equivalent absorber amounts also (IP $\neq$ 0)
IRAD	Radiation calculation flag
ITYPE	Indicator for type of atmospheric path
IV	Frequency of calculations
IV1	Starting frequency
IV2	Last frequency
J	Running integer for altitude identification
JP	Print option parameter
J1	Level indicator for altitude H1
J2	Level indicator for altitude H2
K	General loop variable
KPTS	Elements in P-T matrix used for AK interpolation
KSPEC	Number of species for high resolution calculation (≤ 6)
K2	Cycling parameter for downward path
L	Running index for layers
LBR	Total number of levels transversed in the path
LEN	Parameter used for defining longer of two paths
LL	Running index for level s
LMAP	Counting variable for long path storage
LOOP	Number of layers for low resolution radiance calculations
LSTORE	Counting variable for layer index
LYR	Altitude of Lth layer in path
L1	Frequency identifier for transmittance calculation
L2	Frequency identifier for transmittance calculation

M	Index for model atmosphere
MAX	Number of radiation and transmission calculations
MODEL	Integer used to identify required model atmosphere
M1	Variable to select temperature profile and counting variable
M2	Variable to select water vapor profile
M3	Variable to select ozone profile
N	Loop variable
NEWP	Plot control parameter
NEWS	Plot control parameter
NH	Frequency indicator for water vapor continuum transmittance calculation
NL	Number of levels in model atmosphere data
NLDAT	Number of layers in model atmosphere data
NPT	Number of points in the pressure temperature matrix
NRP	Determines units for radiation output
NRS	Control variable for radiation slit function
NTP	Determines scale for transmittance
NTS	Control variable for transmittance slit function
NUM	Index for locating species on library tape
P	Pressure
PH	Angle of arrival at H2
PHI	Angle of arrival at H2
PI	3.141592654 that is (π)
PP	Pressure values on library tapes
PPW	Partial pressure H_2O
PRES	Pressure at level LL
PS	Total pressure in atmospheres
PSI	Angular deviation of path from initial direction
RAD	Radiance
Range	Path length (km)
RE	Earth radius (km)
REF	Refractive index of air at level L

RH	Relative humidity (%)
RN	Ratio of refractive indices of air above and below a given level
RX	Ratio of earth center distances between adjacent levels
SALP	Sine of angle of arrival at adjacent level (cf sin α)
SPEC	Number of species
SPHI	Sine of the local zenith angle at a given level (cf sin θ)
SR	Slant range (km)
SUM	Sum of optical thicknesses of absorbers 4 thru 8
SUMA	Accumulated integrated absorption
T	Temperature (^{o}K) at level L
TAU	Transmittance
TAU1	Transmittance
TBACK	Background radiation calculation temperature
TEMP	Temperature at level LL
THET	Zenith angle at a given level (in radians)
THETA	Zenith angle at a given level (in degrees)
TMP	Ambient temperature (^{o}C)
TRAN	Total transmission
TRANS	Transmittance from fixed slit function
TRAN1	Broadband transmittance of layer LL
TT	Ratio 273.15/(TMP + 273.15)
TX(K)	Temperature values on library tape
TX(9)	Total transmittance at frequency V
TX(10)	Absorption due to aerosol only at frequency V
TX1	Refractive index of layer above initial altitude H1
V	Frequency (cm^{-1})
VA	Initial frequency in tape data block
VB	Final frequency in tape data block
VCHK1	Used to compare lower frequency of tape data block with calculation frequency

VCHK2	Used to compare upper frequency of tape data block with calculated frequency
VH	Integral of the equivalent absorber amounts from H1 to level L
VIS	Visual range (km) at sea level
VMAX	Max frequency contained in tape
VMIN	Minimum frequency contained in tape
VT	Frequency for fixed slit function
VV	Frequency array read from tape
VV1	Used in interpolating tape input frequencies to calculation frequency
VV2	Used in interpolating tape input frequencies to calculation frequency
VX	Wavelength at which aerosol coefficients are read in (μm)
Vo	Initial calculation frequency
V1	Initial frequency for transmittance calculation, cm^{-1}
V2	Final frequency for transmittance calculation, cm^{-1}
W	Total equivalent absorber amount for entire path
WGAS	Gas concentration
WH	Water vapor density at level L (gm m^{-3})
WH20	Water vapor concentration
WO	Ozone density at level L (gm m^{-3})
WO3	Ozone concentration
WW	Equivalent absorber amount from observer to level L
W2	Water vapor density for atmospheric model M at level L + 1 (gm m^{-3})
X	Input height to POINT subroutine
XD	Wavenumber interpolation parameter
XH	Wavenumber interpolation parameter in H_2O continuum calculation
XI	Wavenumber interpolation parameter

XOR	X-coordinate for lower left corner of plot
XX	Aerosol extinction coefficient
X1	Earth center distance of level L
X2	Earth center distance of level L + 1
Y	Input zenith angle in radians
YN	Refractive index of layer below input height from POINT subroutine
YOR	Y-coordinate for lower left corner of plot
YY	Aerosol absorption coefficient of frequency V
Z	Altitude at level L in km

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